日本古生物学會
報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series No. 32

日本古生物學會
Palaeontological Society of Japan
November 10, 1958

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TRANSACTIONS

All Communications relating to this Journal should be addressed to the

PALAEONTOLOGICAL SOCIETY OF JAPAN

Geological Institute, Faculty of Science, University of Tokyo, Japan

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 32, pp. 271-284, pls. 40-41, Nov. 10, 1958

348. ON THE MIOCENE PECTINIDAE FROM THE ENVIRONS OF SENDAI; PART 12, ON *PECTEN KAGAMIANUS* YOKOYAMA*

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仙台附近中新統産 Pectinidae; その 12, *Pecten kagamianus* YOKOYAMA について: 従来 *Pecten kagamianus* YOKOYAMA とされて来た日本各地からの多数の標本について検討した結果, *Patinopecten kagamianus kagamianus* (YOKOYAMA), *Pat. kagamianus moniwaensis* MASUDA, n. subsp., *Pat. kagamianus nimaensis* MASUDA, n. subsp., *Pat. kagamianus permirus* (YOKOYAMA) の四亜種に分けられることがわかった。これらの各々について記載を行い, 各種間の関係, 地質学的な意義について論じた。
増田孝一郎

Introduction and Acknowledgements

Pecten kagamianus was first described by YOKOYAMA from the Kimachi formation at Kagami, Kimachi-mura, Yatsuka-gun, Shimane Prefecture in 1923. Subsequently it was reported by him as *Pecten permirus* and *Pecten permirus* var. *paucicostata* from near Nanao, Noto Peninsula, Ishikawa Prefecture (1926). Later, the same author (1929) included *Pecten permirus* and *P. permirus* var. *paucicostata* in the synonym of *Pecten* (*Patinopecten*?) *kagamianus* YOKOYAMA, with the statement that it shows considerable variation in the number and size of the radial ribs. MATSUMOTO (1930) described *Pecten plicicostulatus* as new to science from the Moniwa formation in the environs of Sendai City, but this species was included into the synonym of *Pecten kagamianus* YOKOYAMA by NOMURA (1940). These different names show that the present species exhibit variable characters.

Among the fossil Pectinidae known from the Miocene formations of Japan, *Pecten kagamianus* is of particular interest because of its confusing characters, limited geological range, more or less similar lithology of the formations in which it occurs, and rather wide geographical distribution.

Numerous specimens from the Nanao formation in Ishikawa Prefecture, and from the Moniwa and Oido formations in Miyagi Prefecture, those preserved in the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, and in the Saito Ho-on Kai Museum, both in Sendai City, and the materials in the Institute of Geology, Faculty of Science, University of Tokyo in Tokyo, were studied by the writer. The results of examination lead the writer to consider that *kagamianus* may be classified into four subspecies.

In this article the writer describes the morphological characteristics of the *kagamianus* group, and discusses their relationship with related forms. The geological significance, so far as can be judged from the field data, is also given.

* Received Feb. 5, 1958; read at 66th meeting of the Society at Akita, June, 15, 1957.

Acknowledgements are due to Dr. Kotora Hatai of the Department of Geology, Faculty of Education, Tohoku University, for his supervision. Thanks are due to Prof. Sotoji Imamura of the Geological and Mineralogical Institute, Faculty of Science, and Mr. Kazuo Okamoto of the Department of Geology, Faculty of Education, both of the Hiroshima University, for their kind offer of the specimens which they collected from the Miocene deposits in Shimane Prefecture, and also to Miss Yôko Suzuki and Mr. Kôki Nihei, students of the Faculty of Education, Tohoku University, for their assistance in the collection of some specimens.

Description

Family Pectinidae

Subfamily Pectininae

Genus *Patinopecten* Dall, 1898

Patinopecten kagamianus
(Yokoyama), 1923

1923. *Pecten kagamianus* Yokoyama, *Japan. Jour. Geol. Geogr., Vol. 2, No. 1*, p. 8, pl. 1, figs. 1a-b.

Yokoyama's original description is as follows: "Shell large, moderately thick, much compressed (the right valve a little more than the left), orbicular, subequivalve and equilateral. Both valves radiately ribbed. The ribs on the right valve sixteen in number, broad and flatly rounded, straight, broader than the interspaces and with a varying number of longitudinal striae on them; the interspaces shallow, usually a little narrower than the ribs and also longitudinally striated. The ribs on the left valve about equal in number to those of the right, straight, rounded, much narrower than the interspaces and furnished with a few longitudinal striae which are present also on the latter. Shell margin coarsely crenate. The ears seem to be subequal, though the anterior is a little broken. Length and height 105 mm. Thickness 25 mm."

Remarks:—This species is characterized by the large, orbicular, compressed, subequivalve, equilateral shell, flatly rounded radial ribs which are broader than their interspaces and divided into a varying number of longitudinal riblets on their backs in the right valve, and by the left valve having the rounded radial ribs narrower than the interspaces and divided into a few riblets by shallow longitudinal furrows.

The present species has been reported as *Pecten*, *Patinopecten*, and *Vola* and Hatai and Nisiyama (1952) referred it to *Lyropecten*. However, the genus *Lyropecten* is characterized by having the valves with a hump or wave on the umbo and with distinct intercalary threads in the interspaces, and by the hinge furnished with three distinct, oblique, divergent cardinal crura.

Although the generic position of this species is doubtful, the writer refers it to the genus *Patinopecten* with query.

The specimens of the present species from the various mentioned localities show variable characters, and based upon several features they can be classified into four subspecies. They are closely related with one another, but may be distinguished in their number and nature of radial ribs, the apical angle and the depth of valves (Table 1, and figs. 1, 2, 3). The distinguished ones are *Patinopecten kagamianus kagamianus* (Yokoyama), *Pat. kagamianus moniwaensis* Masuda, n. subsp., *Pat. kagamianus nimaensis* Masuda, n. subsp., and *Pat. kagamianus permirus* (Yokoyama), respectively. These are considered to be geographical or

allopatric forms (Mayr, 1942).

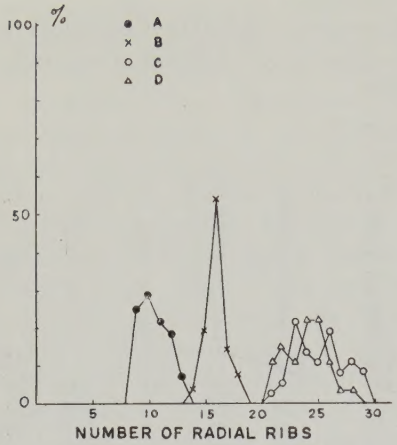
Type locality, Geological formation and Age:—Kagami, Kimachi-mura, Yatsuka-gun, Shimane Prefecture. (Lat. 35°25′N., Long. 132°58′E.) Kimachi formation. Early Miocene.

Depository:—Holotype, Geological Institute, Faculty of Science, University of Tokyo.

Subspecies	Locality	Height (mm.)	Length (mm.)	Hinge-length (mm.)	Depth (mm.)	Apical angle	No. of radial ribs	Valve
k. kagamianus	A	119	115	52	8	105°	17	R
	A	115	113	50	11	100°	16	R
	A	113	113	52	10	100°	17	R
	A	81	78	40	7	100°	16	R
	A	29	26	11	2.5	100°	15	R
	A	100	100	49	11	100°	16	L
	A	—	95	45	10	100°	16	L
	A	87	88	—	10	100°	16	L
	A	84	85	38	10	100°	17	L
	A	47.5	46	21	4	100°	16	L
	I	86	85	—	8	100°	17	R
	I	73	70	30	5	100°	18	R
	I	59	58	—	7	100°	17	L
k. moniwaensis	B	132	—	51	—	100°	11	R
	B	115	110	39	14	100°	12	R
	B	75	74	—	8.5	100°	10	R
	B	50	48	—	6	105°	12	R
	B	50	—	24.5	7.5	110°	10	R
	B	—	46	—	6	—	12	R
	B	37	35	16	—	100°	9	R
	B	19	17	10.5	—	100°	10	R
	B	113	110	48	18	105°	11	L
	B	105	104	—	18	—	11	L
	B	38	35	17	—	100°	9	L
	B	35	34	18	4.5	100°	10	L
	B	35	32.5	15	5	100°	10	L
	B	22	20	9.5	2.5	100°	13	L
	I	68	66	33	8	100°	14	R
	I	68	66	32	9	100°	14	L
	C	125	—	62	—	100°	9	L
k. nimaensis	J	92	85	36	12	90°	12	R
	J	92	85	36	12	90°	12	L
	J	90	84.5	39	12	90°	11	R
	J	90	84.5	39	11	90°	11	L
	J	83.5	—	—	10	90°	11	R
	J	83.5	—	—	10	90°	11	L
	J	—	56	—	9	90°	11	R
	J	—	56	—	9	90°	11	L
k. permirus	F	108	110	—	12	—	23	R
	F	107	110	40	11	105°	24	R
	F	59	60	22	4	100°	26	R
	F	57	56	22	4	100°	23	R
	F	38.5	36	15	3	100°	24	R
	F	36	34	—	—	100°	26	R
	F	32	32	14	2.5	100°	26	R
	F	93	92	—	12	100°	24	L
	F	87	85	—	11.5	100°	25	L
	F	71	70	30	8	105°	21	L
	F	43	41	17	5	105°	24	L
	F	42	38	15.5	4.5	100°	24	L
	F	16.5	15.6	7.5	2	100°	21	L
	G	127	136	50	13	105°	28	R
	G	121	128	50	11	110°	29	R
	G	20.5	19.5	9	2	100°	25	R
	G	106	98	41	12	100°	24	L
	G	66	65	28	—	105°	25	L
	G	46	41	19	—	100°	25	L
	H	53	50	—	—	100°	21	R
	H	104	103	—	12	110°	24	L
	H	100	101	37	13	105°	25	L
	I	63	60	—	5	100°	27	R
	C	73	74	27	5	105°	25	R
	C	71	72	28	5.5	105°	27	R
	C	49	47	—	3.5	105°	28	R
	C	38	35	15	3.5	100°	27	R
	C	35	33	15	2.5	100°	24	R
	C	15	14	7	1.5	100°	23	R
	C	16.5	—	9	2	100°	24	L
	D	115	118	—	10.5	105°	28	R
	D	76	75	32	7	100°	28	R
	D	58	57	23	4.5	100°	28	R
	D	21	—	10	1.5	100°	24	R
	D	15	14.5	8	—	100°	22	R
	D	15	14	8	1.5	100°	22	L
	E	105	110	46	10	100°	26	R
	E	120	120	52	16	100°	23	L

Table 1. Measurements on the selected specimens of the *kagamianus* group.

A—Kanagase, Ôgawara-machi, Shibata-gun, Miyagi Prefecture, B—Moniwa, Sendai City, Miyagi Prefecture, C—Oido, Wakuya-machi, Tôda-gun, Miyagi Prefecture, D—Koganebasama, Wakuya-machi, Tôda-gun, Miyagi Prefecture, E—Iwafune, Wakuya-machi, Tôda-gun, Miyagi Prefecture, F—Iwaya, Nanao City, Ishikawa Prefecture, G—Kokubu, Tokuda-mura, Kashima-gun, Ishikawa Prefecture, H—Hosoguchi, Tokuda-mura, Kashima-gun, Ishikawa Prefecture, I—Hiuchidani, Higashi-Tsuchida-mura, Kashima-gun, Ishikawa Prefecture, J—Akazaki, Nima-machi, Nima-gun, Shimane Prefecture.



Text-fig. 1. Graph showing the frequency of radial ribs.

A—*Patinopecten kagamianus moniwaensis* Masuda, n. subsp. from the Moniwa formation at Moniwa, Sendai City, Miyagi Prefecture.

B—*Pat. kagamianus kagamianus* (Yokoyama) from the Moniwa formation at Kanagase, Ôgawara-machi, Shibata-gun, Miyagi Prefecture,

C—*Pat. kagamianus permirus* (Yokoyama) from the Oido formation at Iwafune, and Koganebasama, Wakuya-machi, Tôda-gun, Miyagi Prefecture.

D—*Pat. kagamianus permirus* (Yokoyama) from the Nanao formation at Iwaya, Nanao City, Ishikawa Prefecture.

Patinopecten kagamianus kagamianus (Yokoyama), 1923

Plate 40, figures 4, 5.

1923. *Pecten kagamianus* Yokoyama, *Japan. Jour. Geol. Geogr., Vol. 2, No. 1*, p. 8, pl. 1, figs 1a-b.

1930. *Pecten plicicostulatus* Matsumoto, *Sci. Rep., Tohoku Imp. Univ., Ser. 2, Vol. 13, No. 3*, p. 105, pl. 40, fig. 15.

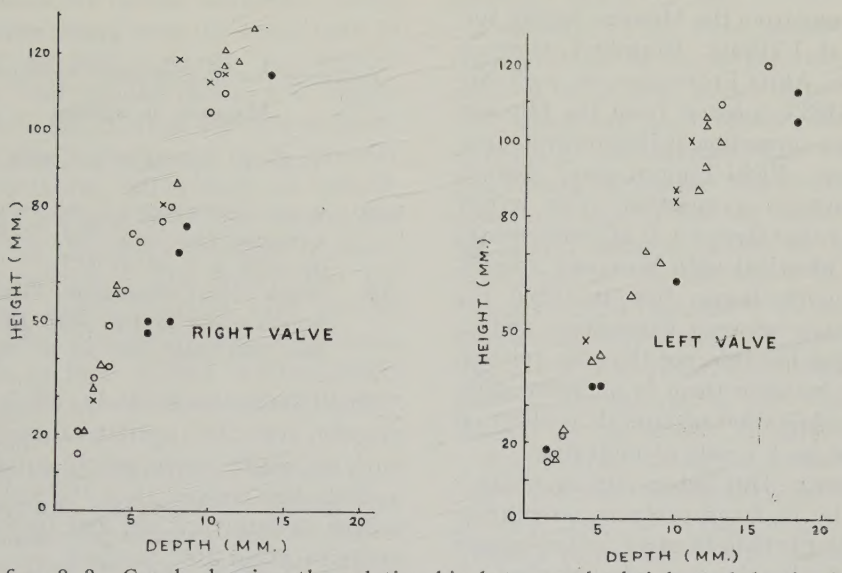
1940. *Pecten (Pecten) kagamianus* Yokoyama, Nomura, *Sci. Rep., Tohoku Imp. Univ., Ser. 2, Vol. 21, No. 1*, p. 16, pl. 2, fig. 15.

1940. *Pecten kagamians* Yokoyama, Nomura and Onisi, *Japan. Jour. Geol. Geogr., Vol. 17, Nos. 3-4*, p. 190, pl. 19, fig. 4.

1950. *Pecten (Lyropecten) kagamianus* Yokoyama, Kubota, *Shinseidai-no-Kenkyû, No. 6*, p. 14, pl. 9, fig. 62.

Shell large, moderately thick, compressed, orbicular, equilateral except for auricles; right valve slightly less convex than the left or nearly equal; both valves radiately ribbed and forming an angle of about 100° at apex.

Right valve with 15 to 18, stout, round-topped radial ribs and fine concentric growth lines; radial ribs broader than their interspaces, divided into a number of fine riblets by shallow longitudinal furrows and rarely dichotomous near the beak with narrow interspaces; longitudinal riblets on the backs of radial ribs appear near upper half of disc and tend to become distinct towards the ventral margin; radial ribs at extreme lateral portions nearly flat, slender and weak; interspaces between the radial ribs deep and smooth in the central part of disc, but shallow near the submargins and with a single or a few weak intercalary threads; anterior auricle sculptured with several radial threads and concentric lines, furnished with rather wide and shallow byssal notch, and rather narrow byssal area; posterior auricle similar to the anterior in sculpture; hinge with wide and shallow resilial pit provided with distinct lateral ridges, rather simple cardinal crura, and ill-developed ctenolium in young shell. Left valve with elevated, round-topped radial ribs which are narrower than their interspaces in breadth and concentric fine growth lines, ornamented by obtuse network; radial ribs rather sharp near the beak but tend to become rounded towards the ventral margin, and divided into several, fine riblets by shal-



Text-figs. 2, 3. Graph showing the relationship between the height and depth of shell.

low longitudinal furrows on lower half of disc; radial ribs near the submargins nearly flat, weak and slender, and with a single or a few, faint intercalary threads; longitudinal riblets on the backs of radial ribs tend to become distinct towards the ventral margin; auricles sculptured with several radial threads and concentric lines, the anterior one a little larger than the posterior. Interior surface of both valves gently folded corresponding to the external sculpture and coarsely crenated at the ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This species resembles *Patinopecten iwasakiensis* (Nomura) (1935) which was described from the Miocene Tanosawa formation at Hotatezawa, Iwasaki-mura, Nishi-Tsugaru-gun, Aomori Prefecture, but *iwasakiensis* can be distinguished from the present one by the left valve which has the radial ribs gradually increasing towards the ventral margin by division and intercalation, no longitudinal riblet on the backs of radial ribs, and by the right valve which has low radial ribs carrying two or three longitudinal shallow grooves on their tops. *Patinopecten yamasakii* (Yokoyama) (1926) which was described from the Miocene Shigarami formation at Shimosoyama, Shigarami-mura, Kami-Minochi-gun, Nagano Prefecture, also resembles the present one, but it possesses a less number of low and rather flat radial ribs which show tri- or bifurcation.

Pecten (*Chlamys*) *kagamianus miyagiensis* described by Nakamura (1940) from the Miocene Ôtsutsumi formation at Ôtsutsumi, Taiwa-machi, Kurokawa-gun, Miyagi Prefecture in the northern border of Sendai is considered to be a synonymy of *Nanaochlamys notoensis* (Yokoyama) (Hatai and Masuda, 1953).

In "A Note on *Pecten kagamianus* Yokoyama" Hatai (1938) mentioned that whether *Pecten* sp. of the *kagamianus* type reported from the Miocene Kunnui formation developed in southwestern Hokkaido by Nagao and Sasa (1934) is identical with Otuka's (1936) questionable

kagamianus from the Miocene Sugota formation at Ukibuta, Higashi-Yuri-mura, Yuri-gun, Akita Prefecture, or with Nomura's (1935) *s-hataii* from the Miocene Tanosawa formation at Hotatezawa, Iwasaki-mura, Nishi-Tsugaru-gun, Aomori Prefecture, is a question. The writer considers that Otuka's *P.* aff. *kagamianus* may be identical with Nomura's species. Furthermore, Hatai has discussed the relationship between *kagamianus* and *s-hataii*, and has inferred that the relation existing between them is an interesting case of adaptation or lateral localization produced as a result of migration.

Remarks:—This subspecies is characterized by its large, orbicular, compressed shell with 15 to 18, stout, round-topped radial ribs bearing a number of close-set longitudinal riblets on their backs, by the hinge with rather simple cardinal crura, by the ctenolium in young shells, by the wide and shallow resilial pit provided with distinct lateral ridges in the right valve, and by the left valve which is ornamented by elevated radial ribs bearing several longitudinal riblets on their backs, and by the interspaces being wider than the radial ribs and the obtuse network. The right valve is usually a little less convex than the left one or sometimes subequal to it, but it seems that the right valve is sometimes a little more convex than the left as pointed by Yokoyama (1923).

Described specimens:—Kanagase, Ôgawara-machi, Shibata-gun, Miyagi Prefecture. Calcareous sandstone of the Moniwa formation. DGS, Reg. No. 3518.

Distribution:—Kimachi formation in Shimane Prefecture, Moniwa formation in Miyagi Prefecture, and Nanao formation in Ishikawa Prefecture; all Early Miocene in age.

Patinopecten kagamianus moniwaensis Masuda, n. subsp.

Plate 41, figures 3, 4, 5, 6a-b.

1929. *Pecten (Patinopecten?) kagamianus* Yokoyama, *Imp. Geol. Surv. Japan, Rep. No. 104*, p. 2, pl. 1, fig. 1.

1936. *Pecten (Vola) kagamianus* Yokoyama, Nomura and Zinbo, *Saito Ho-on Kai Mus., Res. Bull., No. 10*, pl. 20, fig. 3.

Shell large, moderately thick, compressed, orbicular, equilateral except for auricles; right valve nearly equal to or a little less convex than the left; both valves radiately ribbed and forming an angle of about 100° at apex.

Right valve with about 10, rather low, round-topped radial ribs, a single or a few intercalary threads between radial ribs near the submargins, and fine concentric growth lines; radial ribs much broader than their interspaces, and divided into numerous, fine riblets by shallow longitudinal furrows; longitudinal riblets on the backs of radial ribs variable in strength and number, and first appear at about half of disc length and tend to become distinct towards the ventral margin; radial ribs at the lateral extremities very low and slender, and with interspaces variable in breadth; interspaces between the radial ribs shallow and smooth in the central part of disc; anterior auricle furnished with wide and shallow byssal notch and rather narrow byssal area; posterior auricle sculptured with several, weak radial threads and concentric lines; hinge with simple cardinal crura, and wide and shallow resilial pit provided with lateral ridges, and furnished with ill-developed ctenolium in young shell. Left valve with stout, elevated, round-topped radial ribs and concentric growth lines, and

ornamented by obtuse network; radial ribs rather sharp near the beak, tend to become rounded towards the ventral margin, and divided into a few riblets by shallow longitudinal furrows on lower half of disc; interspaces much broader than radial ribs, rather deep and smooth, and with a single or a few intercalary threads in the lateral portions of disc; anterior auricle a little larger than the posterior, and sculptured with several weak radial threads and concentric lines. Interior surface of both valves gently folded and coarsely crenated at the ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity—*Patinopecten kagamianus kagamianus* can be distinguished from the present one by having rather thick shell, more numerous elevated radial ribs with more numerous and more distinct radial threads on the surface of auricles than that of *moniwaensis*.

This subspecies is related with *Patinopecten kimurai* (Yokoyama) (1925) which was described from the Miocene Kamenoo formation (Hatai and Nisiyama, 1952) in Fukushima Prefecture, but *kimurai* is distinguishable from the adult specimens of the present one by having more elevated radial ribs, less distinct and less number of faint longitudinal riblets on the backs of radial ribs in the right valve, and by the roof-shaped radial ribs which remain undivided in the left valve. However, at times it is difficult to distinguish the young shells of the present one from *kimurai*, because in the young *kagamianus moniwaensis* the radial ribs of the right valve lack longitudinal riblets on the backs of radial ribs, and the radial ribs of the left valve show roof-like shape with no riblet on their backs. Thus the writer considers that the present one and *kimurai* probably had a common ancester.

Remarks:—This new subspecies is characterized by its large, rather thin shell, 9 to 13, low, round-topped radial ribs which are much broader than their interspaces and divided into numerous fine riblets by shallow longitudinal furrows, very slender and low radial ribs at the lateral portions of disc in the right valve, and by the left valve in having elevated radial ribs which are much narrower than their interspaces and divided into a few, fine riblets by shallow long-i tudinal furrows, and a few, fine radial threads on the surface of auricles.

Type locality, Geological formation and Age:—Moniwa, Sendai City, Miyagi Prefecture, Lat. 38°13′N., Long. 140°47′E. Moniwa formation. Early Miocene.

Depository:—Holotype, DGS, Reg. No. 3506, Paratypes, DGS, Reg. No. 3507 and No. 1476.

Distribution:—Moniwa formation in Miyagi Prefecture, Nanao formation in Ishikawa Prefecture, and Yanagawa and Futatsugoya formations in Fukushima Prefecture; all Early Miocene in age.

Patinopecten kagamianus nimaensis Masuda, n. subsp.

Plate 41, figures 1, 2.

Shell moderate, moderately thick, higher than long, compressed, equilateral except for auricles; right valve nearly equal or a little more convex than the left; both valves radiately ribbed and forming an angle of about 90° at apex.

Right valve with about 11, elevated, round-topped, smooth radial ribs, and fine concentric growth lines, ornamented by obtuse network; radial ribs much broader than their interspaces on upper half of disc but tend to become subequal towards the ventral margin, and divided

into several, fine riblets by shallow longitudinal furrows, and rarely dichotomous near the beak with narrow interspaces; riblets on the backs of radial ribs on central part of disc usually appear near the ventral margin, but at the lateral portions they appear on upper half of disc; radial ribs at the lateral portions of disc very low and weak; interspaces between the radial ribs rather smooth, but sometimes with a single or a few, faint intercalary threads; anterior auricle nearly equal to the posterior one, sculptured with several radial threads and concentric lines, and furnished with wide and shallow byssal notch and rather wide byssal area; posterior one similar to anterior in sculpture. Left valve with elevated radial ribs and weak concentric growth lines, and ornamented by fine network; radial ribs narrower than their interspaces, rather sharp near the beak, tend to become rounded and broad towards the ventral margin, and divided into a few, fine riblets by shallow longitudinal furrows on lower half of disc; radial threads on the backs of radial ribs fine and weak, but the middle one extends to the beak; radial ribs at the lateral portions low and slender; auricles sculptured with several, fine radial threads and concentric lines; hinge with simple cardinal crura, and wide and shallow resilial pit provided with shallow lateral sockets. Interior surface gently folded.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This new subspecies can be distinguished from *kagamianus moniwaensis* by the shell being higher than long, small apical angle, elevated radial ribs, rather wide and deep interspaces, and fine network in the right valve. Also it can be distinguished from *kagamianus kagamianus* by the higher shell, less number of radial ribs, and smaller apical angle.

Remarks:—This new subspecies is characterized by its higher than long, compressed shell, fine network on the surface, 11 to 12, round-topped radial ribs which are a little broader than or nearly equal to the interspaces in breadth, and divided into several, fine riblets by shallow longitudinal furrows near the ventral margin on the central part of disc and on upper half of disc at the lateral extremities, and by the left valve having rather distinct network on the surface, elevated radial ribs which are divided into a few, fine riblets by shallow longitudinal furrows.

Type locality, Geological formation and Age:—Railroad cutting on the San-in Line at Akazaki, Nima-machi, Nima-gun, Shimane Prefecture. Lat. 35°00′43″ N., Long. 132°24′40″ E. Kawai formation. Early Miocene.

Depository:—Holotype, Reg. No. T.NM. 26, Geological and Mineralogical Institute, Faculty of Science, Hiroshima University. Paratype, DGS, Reg. No. 3580.

Occurrence:—Kawai formation at type locality and Tachime, Nima-machi, Nima-gun, and Tamatsukuri formation at Ushirobane, Mitoya-machi, Hanseki-gun, all in Shimane Prefecture.

Patinopecten kagamianus permirus (Yokoyama), 1926

Plate 40, figures 1a-b, 2, 3.

1926. *Pecten permirus* Yokoyama, *Jour. Geol. Soc. Tokyo, Vol. 33*, p. 10, pl. 2, fig. 1.
1926. *Pecten permirus* var. *paucicostata* Yokoyama, *Ibid.*, p. 10, pl. 2, fig. 2.
1929. *Pecten* (*Patinopecten ?*) *kagamianus* Yokoyama, *Imp. Geol. Surv. Japan, Rep. No. 104*, p. 2, pl. 1, fig. 2, pl. 2, figs. 1, 2.
1935. *Patinopecten kagamianus* (Yokoyama), Otuka, *Bull. Earthq. Res. Inst., Vol.*

13, Pt. 4, p. 888, pl. 55, figs. 138, 144.

Shell large, thick, compressed, orbicular, equilateral except for auricles; right valve a little less convex or subequal to the left; both valves radiately ribbed and forming an angle of about 100° at apex.

Right valve with 21 to 29, stout, elevated, round-topped radial ribs and fine concentric growth lines; radial ribs broader than their interspaces, and divided into several, fine riblets by shallow longitudinal furrows; riblets on the backs of radial ribs usually appear on upper half of disc, and tend to become distinct towards the ventral margin; radial ribs at the lateral extremities very weak and slender; interspaces between the radial ribs deep and smooth, but shallow near the submargins and sometimes with a single or rarely a few, very weak intercalary threads; anterior auricle sculptured with several, fine radial threads and concentric lines, and furnished with rather wide and shallow byssal notch and rather wide byssal area; posterior one similar to anterior in sculpture; hinge with conspicuous cardinal crura, rarely with rather flat hinge plate with very faint striae parallel to the hinge line in full adult specimen, deep and wide resilial pit provided with distinct lateral ridges, and ill-developed ctenolium in young shell. Left valve with elevated, slender radial ribs and concentric growth lines, and ornamented by obtuse network; radial ribs much narrower than their interspaces, divided into a few, fine riblets by shallow longitudinal furrows on lower half of disc; radial ribs at lateral extremities very weak and slender, and with a single or a few, fine intercalary threads in their interspaces; auricles sculptured with about ten radial threads and concentric lines, and anterior one somewhat larger than the posterior. Interior surface of both valves gently folded and coarsely crenated at the ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This subspecies can be distinguished from *kagamianus kagamianus, kagamianus moniwaensis* and *kagamianus nimaensis* by the thick shell, larger number of radial ribs, characteristics of radial ribs and auricles, and the hinge area.

Remarks:—This subspecies is characterized by its rather thick, compressed shell, 21 to 29, elevated, round-topped radial ribs which are divided into several, fine riblets, conspicuous cardinal crura, deep and wide resilial pit provided with distinct lateral ridges, and rather wide byssal area.

Type locality, Geological formation and Age:—Iwaya, Nanao City, Ishikawa Prefecture. Lat. 37°01′03″ N., Long. 136°57′04″ E. Nanao formation. Early Miocene.

Depository:—Lectotype, University of Tokyo (Yokoyama, 1926, pl. 2, fig. 1, here designated).

Described specimens:—Iwaya, Nanao City, Ishikawa Prefecture. Calcareous sandstone of Nanao formation. DGS, Reg. No. 1888.

Distribution:—Nanao formation in Ishikawa Prefecture and Oido formation in Miyagi Prefecture; both Early Miocene in age.

Mode of Occurrence and Geological Significance

The Moniwa formation at Moniwa, Sendai City, Miyagi Prefecture where abundant specimens of *kagamianus moniwaensis* occur, consists of granule conglomerate with some rounded pebbles to conglomeratic very coarse-grained sandstone containing also *Nanaochlamys notoensis* (Yokoyama), *Placopecten nomurai* Masu-

da, *Cryptopecten yanagawaensis* (Nomura and Zinbo), etc., other pelecypods, gastropods, echinoids, balanids, brachiopods and bryozoans. Among the pectinid fossils, a rather large number of *kagamianus moniwaensis* consist of somewhat water-worn and some with more or less broken shells, both of which are arranged parallel with the bedding plane. Though some specimens have their concave side upwards, or irregular, the majority are arranged with their convex side upwards. Among the pectinids from the Moniwa formation at Moniwa, the thin and fragile *Placopecten nomurai* is abundant, rather well preserved and occur as isolated or sometime as intact valves. *Nanaochlamys notoensis* and *Cryptopecten yanagawaensis* both of which occur in association with the mentioned ones occur as isolated valves, but are better preserved than *kagamianus moniwaensis*. From the field data at Moniwa, it is considered that the shells of *kagamianus moniwaensis* were transported from a distance greater than the other mentioned species of Pectinidae.

Some specimens of *kagamianus moniwaensis* were collected from the granule conglomerate to very coarse-grained sandstone of the Moniwa formation at Kita-Akaishi, Sendai City, about 3 km. west of Moniwa, in association with *Cryptopeten yanagawaensis*, *Nanaochlamys notoensis*, etc. They occur as isolated valves, with the convex sides upwards or rarely downwards, and are arranged parallel with the bedding plane. These may have been transported from the site of living to that of burial.

Several specimens of *kagamianus kagamianus* were collected from the granule conglomerate of the Moniwa formation at Kumanodô, Natori-machi, Natori-gun, about 4 km. SE of Moniwa, in association with pectinids as *Nanaochlamys notoensis*, *Chlamys kumanodôensis* Masuda, *Placopecten akihoensis* (Matsumoto), etc., other pelecypods, gastropods, brachiopods, corals, echinoids and bryozoan-fragments. These pectinids occur as isolated valves, more or less water-worn, and arranged parallel with the bedding plane with the convex sides upwards or very rarely downwards.

Abundant specimens of *kagamianus kagamianus* from the calcareous sandstone of the Moniwa formation at Kanagase, Ôgawara-machi, Shibata-gun, about 18 km. south of Moniwa, were found associated with some *Placopecten akihoensis*, *Nanaochlamys notoensis*, a few *Cryptopecten yanagawaensis*, and gastropods, brachiopods, balanids, echinoids and bryozoan-fragments. These occur as rather well preserved isolated or very rarely intact valves, arranged parallel with the bedding plane and with the convex sides upwards. In the case of specimens with intact valves, it is considered that they were probably buried *in situ*, because of their natural orientation.

From the field data, it is probable that the shells of *kagamianus kagamianus* at Kumanodô were transported from the site of living to that of burial, while those from Kanagase lived in the environment in which they were buried, or at least they were not carried from a remote place.

From the available data concerning the Moniwa formation, it is considered that the depositional conditions at Moniwa and Kita-Akaishi were somewhat different from those of Kumanodô and Kanagase, as can be judged from the rock facies and the associated fauna. Thus it is evident that *Patinopecten kagamianus moniwaensis* and *Pat. kagamianus kagamianus* are allopatric forms (Mayr, 1942).

The Nanao formation at Iwaya, Nanao

City, Ishikawa Prefecture from where numerous specimens of *kagamianus permirus* occur, consists of richly calcareous sandstone containing *Nanaochlamys notoensis, Placopecten akihoensis, Chlamys ingeniosa* (Yokoyama), etc., foraminifers, brachiopods, echinoids, bryozoans, balanids and sponge spicules. All specimens of *kagamianus permirus* so far as observed occur as isolated valves arranged parallel with the bedding plane and with the convex sides upwards. Some water-worn shells or fragments are found in association.

The specimens from the calcareous sandstone of the Nanao formation at Hosoguchi and Kokubu, about 1.5 km. south of Iwaya, Tokuda-mura, Kashima-gun, include *Patinopecten kagamianus permirus* and rarely *Pat. kagamianus moniwaensis*. Their mode of occurrence are quite similar to that of Iwaya.

From the mode of occurrence it is considered that the specimens of the *kagamianus* group from the Nanao formation were transported from the site of living to that of burial.

The specimens from the medium-grained sandstone of the Nanao formation at Hiuchidani, Higashi-Tsuchida-mura, Kashima-gun, about 13 km. west of Iwaya, comprise *Patinopecten kagamianus kagamianus, Pat. kagamianus moniwaensis* and *Pat. kagamianus permirus*. At that locality, *kagamianus moniwaensis* is the dominant species and occurs with intact or isolated valves, while the others occur as isolated more or less water-worn valves. These evidences suggest that *kagamianus moniwaensis* at Hiuchidani lived in the environment in which it was buried, at least it was not transported from a remote place, while the other species were brought from their site of living to that of burial. Lithology and fauna show that the depositional conditions at Iwaya, Hosoguchi and Kokubu were different from that at Hiuchidani.

Several authors (Newell, 1948, Burma, 1948, Sylvester-Bradley, 1951, et al.) maintain that closely related subspecies are not found together in the same bed at the same place, Fleming (1957) states that different species of *Pecten* s. str. are seldom sympatric and there is no such record in Australasia. However, Shuto (1957) has discussed the occurrence of sympatric species of *Paphia* from the Miyazaki group developed in Miyazaki Prefecture, Japan.

In the case of the Nanao formation the writer considers that the three subspecies are allopatric but not sympatric forms. The reasons for such a view are that a certain subspecies dominates a population at a given locality, one subspecies occurs more frequently than the others when coexisting with two or three subspecies, and further, evidences of transportation from the site of living to that of burial also favors their allopatric nature.

Intact valves of *Patinopecten kagamianus permirus* collected from the medium-grained sandstone of the Oido formation at Iwafune, Wakuya-machi, Tôda-gun, Miyagi Prefecture, about 47 km. NNE of Moniwa, are arranged parallel with the bedding plane and with natural orientation, therefore, they were probably buried *in situ*. The isolated valves of *kagamianus permirus* from the said locality occur in association with *Placopecten akihoensis, Placopecten wakuyaensis* Masuda, other pelecypods, gastropods, brachiopods, and bryozoan-fragments; all are rather well preserved. Thus, the fauna was not transported from a remote place. The specimens of *kagamianus permirus* collected from the tuffaceous conglomeratic to very coarse-grained

sandstone of the Oido formation at Oido and Koganebasama, Wakuya-machi, associated with abundant *Placopecten akihoensis*, *Placopecten wakuyaensis*, *Chlamys kaneharai* (Yokoyama), *Chlamys* cf. *hataii* Masuda and Akutsu, *Nanaochlamys notoensis*, etc., other pelecypods, gastropods, brachiopods, echinoids, balanids and bryozoan-fragments, occur as isolated valves. The majority of them are water-worn shells, or sometimes fragments, but they are usually arranged parallel with the bedding plane and with the convex sides upwards. Therefore, it is inferred that the Oido and Koganebasama specimens of *kagamianus permirus* may have been transported from elsewhere.

Since the associated fauna of the Oido formation suggests that they are approximately of the same age as the Moniwa formation, it is considered these afford further evidence that *Patinopecten kagamianus permirus* of the Oido formation, and *Pat. kagamianus kagamianus* and *Pat. kagamianus moniwaensis* are allopatric forms.

Some intact valves of *Patinopecten kagamianus nimaensis* were collected from the very fine-grained sandstone of the Kawai formation at Akazaki, Nimamachi, Nima-gun, Shimane Prefecture. Since they do not occur from the same formation as that of *Pat. kagamianus kagamianus* which is yielded from the Kimachi formation, it is considered that *kagamianus nimaensis* and *kagamianus kagamianus* are probably allochronic forms (Mayr, 1942) in this region. Since the fossil fauna of the Kawai formation indicates an Early Miocene age and may be correlated with the other mentioned formations carrying *kagamianus kagamianus*, *kagamianus moniwaensis* and *kagamianus permirus*, it is considered that these subspecies are probably geographical or allopatric forms. However, conclusive remarks must be given after the detailed stratigraphy of the Akazaki region has been completed.

In general, the *kagamianus* group collected from sandstone or calcareous sandstone are usually rather well preserved, and sometimes occur with intact valves, but those from granule conglomerate or conglomeratic sandstone are rather ill-preserved and occur as isolated valves, and the majority are water-worn or sometimes fragmentary.

From the mentioned facts, it is inferred that the *kagamianus* group probably prefered a shallow clean sea bottom

Explanation of Plate 40

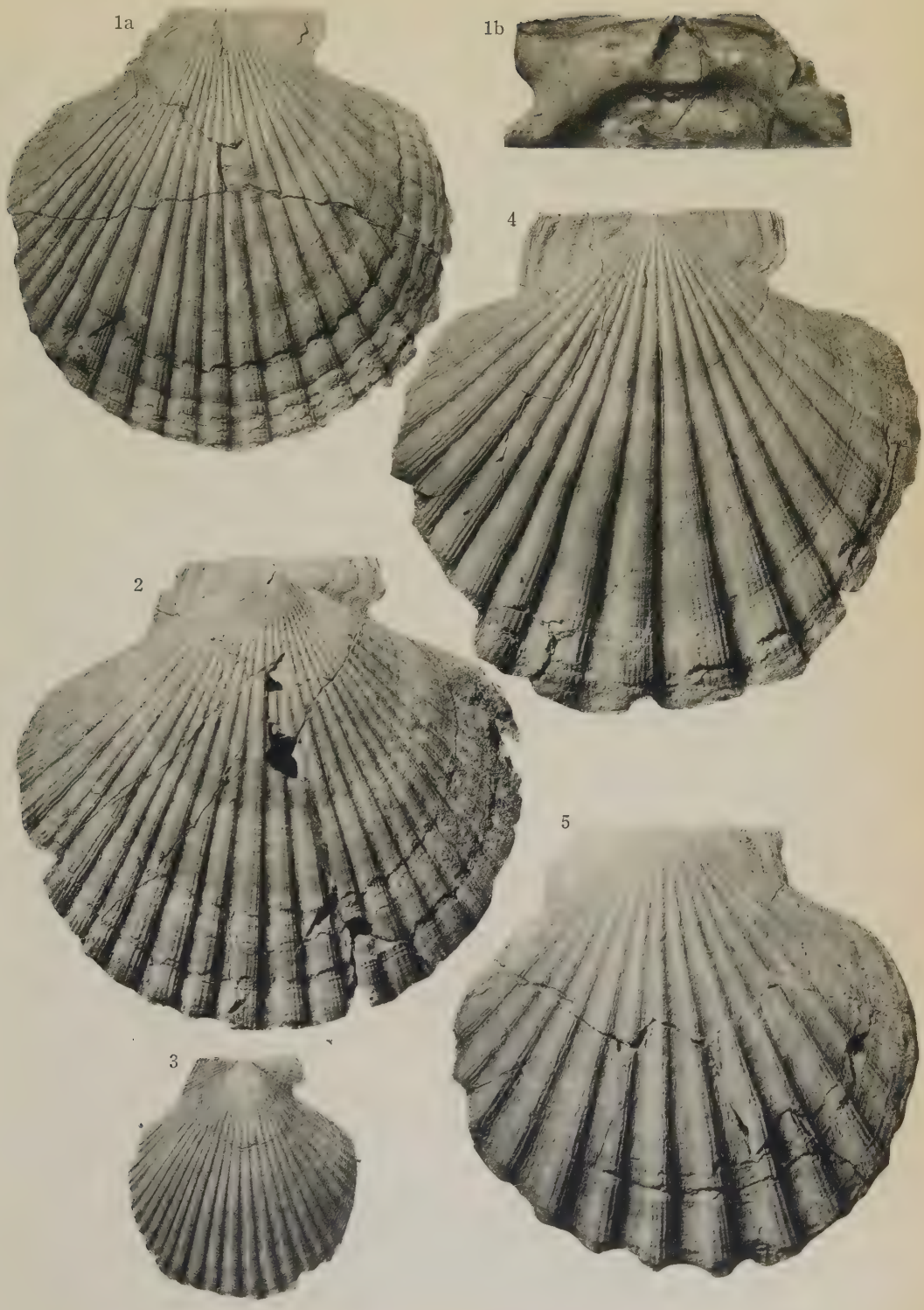
Figs. 1a-b. *Patinopecten kagamianus permirus* (Yokoyama), a, Right valve, ×3/5, b, Hinge area of fig. 1a, ×1. DGS, Reg. No. 1888. Loc. Iwaya, Nanao City, Ishikawa Prefecture. Nanao formation.

Fig. 2. *Patinopecten kagamianus permirus* (Yokoyama), Right valve, ×2/3. DGS, Reg. No. 3253. Loc. Iwafune, Wakuya-machi, Tôda-gun, Miyagi Prefecture. Oido formation.

Fig. 3. *Patinopecten kagamianus permirus* (Yokoyama), Right valve, ×1. DGS, Reg. No. 3333. Loc. Oido, Wakuya-machi, Tôda-gun, Miyagi Prefecture. Oido formation.

Fig. 4. *Patinopecten kagamianus kagamianus* (Yokoyama), Right valve, ×4/5. DGS, Reg. No. 3518. Loc. Kanagase, Ôgawara-machi, Shibata-gun, Miyagi Prefecture. Moniwa formation.

Fig. 5. *Patinopecten kagamianus kagamianus* (Yokoyama), Left valve, ×4/5. DGS, Reg. No. 3518. Loc. Same as above.



K. Masuda photo.

consisting of sand or shelly sand quite free from muddy materials and influenced by warm thermal conditions.

The geological range of the mentioned subspecies of *kagamianus* is restricted to Early Miocene in a two-fold division.

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Explanation of Plate 41

Fig. 1. *Patinopecten kagamianus nimaensis* Masuda, n. subsp. Holotype, Reg. No. T. NM. 26, Geological and Mineralogical Institute, Faculty of Science, Hiroshima University. Right valve, ×7/8. Loc. Akazaki, Nima-machi, Nima-gun, Shimane Prefecture. Kawai formation.

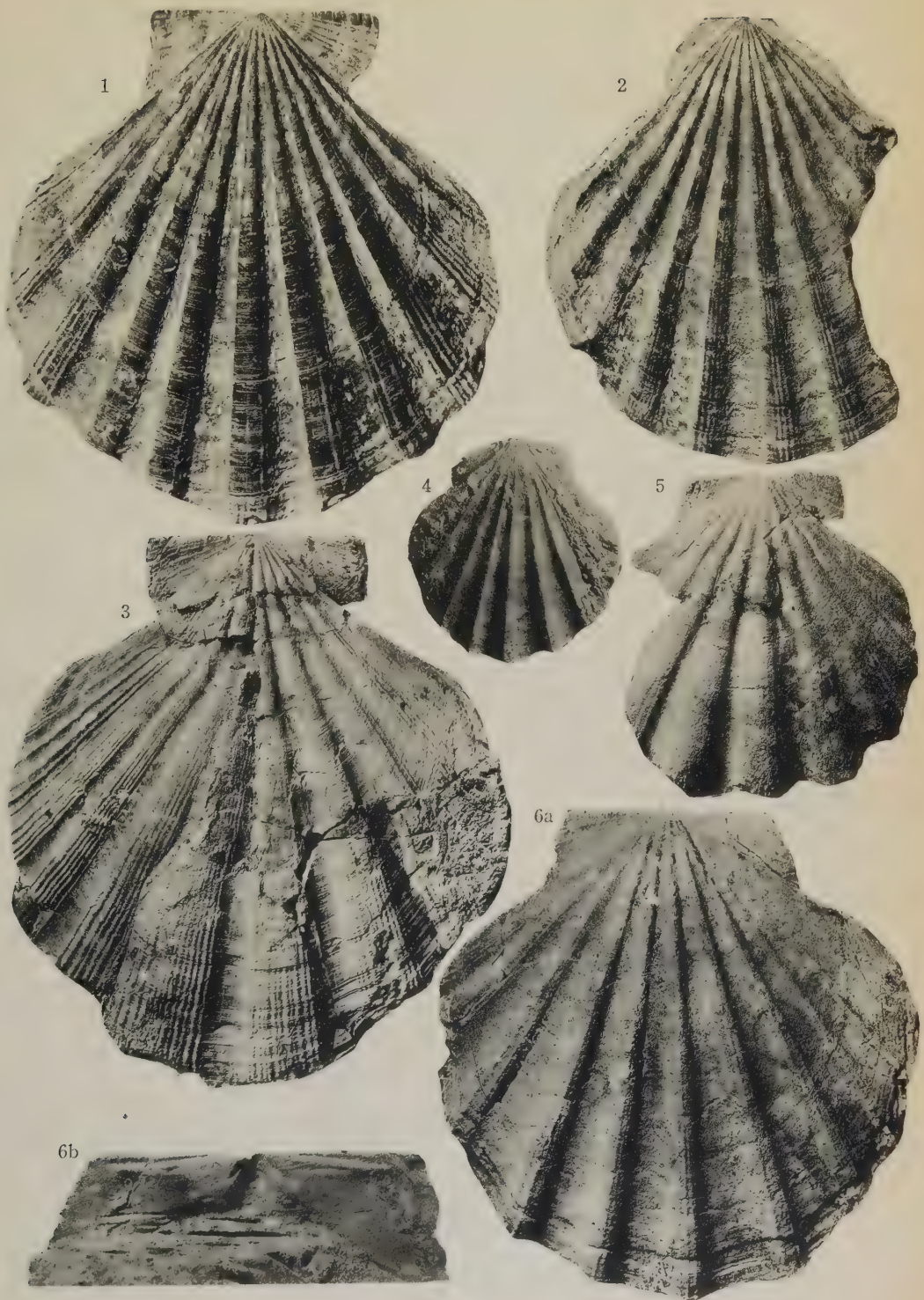
Fig. 2. *Patinopecten kagamianus nimaensis* Masuda, n. subsp. Paratype, DGS, Reg. No. 3580. Left valve, ×7/8. Loc. Same as above.

Fig. 3. *Patinopecten kagamianus moniwaensis* Masuda, n. subsp. Holotype, DGS, Reg. No. 3506. Right valve, ×2/3. Loc. Moniwa, Sendai City, Miyagi Prefecture. Moniwa formation.

Fig. 4. *Patinopecten kagamianus moniwaensis* Masuda, n. subsp. Paratype, DGS, Reg. No. 1476. Left valve, ×1. Loc. Same as above.

Fig. 5. *Patinopecten kagamianus moniwaensis* Masuda, n. subsp. Paratype, DGS, Reg. No. 1476. Right valve, ×1. Loc. Same as above.

Figs. 6a-b. *Patinopecten kagamianus moniwaensis* Masuda, n. subsp. Paratype, DGS, Reg. No. 3507. a, Left valve, ×2/3, b, Hinge area of Fig. 6a, ×1. Loc. Same as above.



K. Masuda photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 32, pp. 285-290, pl. 42, Nov. 10, 1958

349. MOLLUSCAN FAUNA FROM THE TERTIARY FORMATION OF CHIRAI, KAMISAROMA, KITAMINO-KUNI, HOKKAIDO*

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北海道北見国上佐呂間，知来付近の第三系産貝化石群について：筆者の1人橋本は北海道北見国上佐呂間，知来付近に発達せる第三系から海棲貝化石を採集した。かって本地域から *Pecten kaneharai* が報告されたことがあり，その分布上興味をもたれていたので，筆者らはその貝化石群を検討し，これら貝化石群の地質時代ならびに分布上に関する問題を論じ，*Miyagipecten* の1新種，および*Patinopecten* 1種を記載した。
橋本　亘・菅野三郎

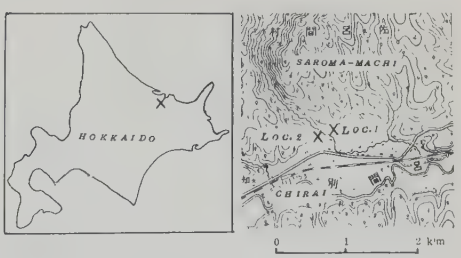
Introduction and Acknowledgements

In 1951, TAKEDA and KITAGAWA briefly wrote on the limestone resources in the Chirai area, Saroma-machi, Kitamino-kuni, Hokkaido, and referred to a marine Tertiary formation yielding such molluscan fossils as *Pecten kaneharai* YOKOYAMA, *Pecten* spp., and *Cardium* sp.

According to this paleontological data, the senior author correlated this formation with the Kawabata which is developed in Central Hokkaido when he compiled the geological map of Hokkaido in the scale of 1: 200.000; this was published from the Geological Survey of Hokkaido in 1957.

Since then, particularly from the interest of the first report of "*Pecten kaneharai*" from the Okhotsk side of Hokkaido and also to its stratigraphic significance in relation with the cold water fauna of the Tokoro formation developed in an adjoining area, the senior author visited the above mentioned locality**, and he made a collection of the molluscan fossils including some interesting scallops described in this article, though he failed to discover "*Pecten kaneharai* YOKOYAMA".

The writers wish to thank Prof. Kotora HATAI of our Institute for his valuable suggestions. Acknowledgements are due to Messrs. Akitoshi INOMA, Hisashi MIZUMOTO, and Hikosuke WATANABE, students of our Institute, and Mr. Rikio YAMADA, a farmer residing in the area of the fossil locality, for their kind assistance in collecting the fossils.



Text-fig. 1. Maps showing the geographic position of the fossil locality.

* Received Feb. 26, 1958; read Feb. 2, 1958.
** Financed by the Science Research Expenditures Fund of the Ministry of Education.

Geology and Fauna

The Tertiary formation in the Chirai area is very limited in its development and unconformably overlies the Saroma group of so-called Mesozoic age; it dips very gently to the south.

The lithologic succession of the formation is as follow; the lowest part consists of granule conglomeratic porous sandstone of reddish brown tinge mainly due to the cementing material of iron oxide; this is superposed with an irregular alternation of brown sandstone and reddish brown conglomerate as a transitional part to the next younger massive brown sandstone which is in turn conformably overlain by a bed of yellowish light grey tuff. The first and the last mentioned beds yield molluscan fossils, but the former is superior to the latter in number of individuals.

The lowest, the reddish brown conglomeratic sandstone (Loc. 1) yielded abundant individuals of *Glycymeris* cf. *idensis* KANNO, *Chlamys* (*Swiftopecten*) *swiftii* (BERNARDI), "*Pecten*" sp., and *Miyagipecten saromensis* HASIMOTO and KANNO, n. sp., among which the last mentioned is the most predominant. The pelecypods are largely represented by isolated valves arranged horizontally with the convex surface above. The shell materials of them are hardly preserved, and almost all are represented as moulds.

The uppermost, yellowish tuff (Loc. 2) yielded *Glycymeris* cf. *idensis* KANNO, *Patinopecten* aff. *kobiyamai* KAMADA, *Crenella tomiyaensis* HATAI and NAKAMURA, *Spisula* sp., and *Turritella s-hataii* NOMURA.

Among the mentioned molluscan fossils, *Chlamys* (*Swiftopecten*) *swiftii* (BERNARDI) ranges from Miocene to Recent, however, the others are limited from middle to upper Miocene in Japan. The fauna taken as a whole apparently represents a rather warm water assemblage like that of the Nanakita formation in Miyagi Prefecture, where *Glycymeris matsumoriensis* HATAI and NAKAMURA, *Miyagipecten matsumoriensis* MASUDA, *Chlamys kaneharai* (YOKOYAMA), *Crenella tomiyaensis* HATAI and NAKAMURA, and *Dosinia kaneharai* YOKOYAMA are characteristic. It may be added that *Patinopecten chiganouraensis* NAKAMURA and *Turritella s-hataii* NOMURA have been reported from the Shiogama Miocene which is considered to be a correlative of the Nanakita. *Patinopecten chiganouraensis* NAKAMURA is allied to *P. kobiyamai* KAMADA, though precise comparison of the two is difficult owing to the poor preservation of the former.

From the above consideration, the writers conclude that the Chirai fauna is a correlative of the Nanakita and the Shiogama. Therefore, the geological age of the Chirai fauna may be considered as middle Miocene, at least, not younger than the upper Miocene.

The Chirai formation is distributed in an isolated small area patched in the Toyokoro-Kitami tectonic zone in broad sense (HASIMOTO, 1958) where there is no development of the typical green tuff facies, regardless of that it is situated between the "green tuff regions" of the Okhotsk side of central Hokkaido and the Inner zone of the Chishima (Kuriel) geo-tectonic structure.

The yellowish tuff bed of the Chirai formation with above mentioned fauna suggests that it is a marginal facies of the "green tuff formation" of the Kitami region. Among its fauna *Turritella* cf. *s-hataii* is common to a coal-bearing formation developed in the "green tuff area" in the west of Ikutawara-machi, west of the Chirai area. (HASIMOTO and

Nagao, 1956).

In the east of the Chirai area, there develops the oil-bearing Neogene Tertiary group which is superposed unconformably on the late Mesozoic deposits. The following geological succession has been reported; namely, the Tokoro formation (or the Kurumatomanai) of clastic sediments is overlain by the Abashiri formation of pyroclastic nature. The former was once considered to be of the Oligocene Poronai stage owing its faunal elements, but recently it is correlated with the cold water type deposits of the Takinoue stage (Sasa and Inoue, 1939; Shimada and Yasaki, 1957), and is middle and lower Miocene in age. The latter is correlated with the Kawabata formation in central Hokkaido.

The cold water type of the Takinoue stage is represented by the Chikubetsu fauna which includes several Poronai elements, while the southern one is characterized by the warm water Takinoue fauna which has been correlated with the lower Kadonosawa fauna of Iwate and Miyagi Prefectures.

According to Fujie and Uozumi (1957), the Kawabata fauna (in their revised meaning) is said to be distinguishable from the Takinoue fauna in broad sense being the younger one, but no description of the faunal assemblage has been published to date.

Since the Chirai fauna, as already stated, is compared with the Nanakita fauna, it is younger than the Takinoue fauna and older than the Tôgeshita fauna of the upper Miocene Wakkanai stage (Hasimoto, 1950), accordingly it is considered to be of the Kawabata stage.

If the foregoing remarks are accepted, it is possible to consider that the warmer Kawabata fauna overlaps the cold Chikubetsu fauna in the southern Kitami region. In this case, the problem arises as to how was introduced such a warm fauna into the Okhotsk region. Presently we have no information on a fauna equivalent with the Chirai from anywhere in the eastern part of Hokkaido.

Systematic Description

Family Pectinidae

Subfamily Pectininae

Genus *Miyagipecten* Masuda, 1952

Miyagipecten saromensis Hasimoto and Kanno, n. sp.

Plate 42, Figures 1-5.

Shell moderate in size, orbicular, subequivalve, equilateral, much compressed. Right valve smooth, sculptured with very fine concentric lines of growth and indistinct radial threads; auricles subequal in size, sculptured with concentric growth lines and wide and shallow byssal notch; interior surface inaccessable. Left valve ornamented with radial striations and faint concentric growth lines; radial striations numbering about 20, tend to become obsolete on lower half of disc, and associated with an intercalary between them; intercalary radials disappear on lower half of disc in adult shell, while the main radials extend to its base, though they are rather indistinct; radial striations separated by interspaces much broader than their width; auricles subequal, though the anterior one is slightly larger than the posterior, marked with about five radial ribs and closely arranged concentric growth lines; internal surface slightly grooved in accordance with the surface ornamentation. Height, 66 mm.; length, 67 mm.; hinge-length, 25 mm.; depth, ca. 6 mm.; apical angle, 105°

measured on a plaster-cast of the holotype (right valve).

Comparison:—*Miyagipecten matsumoriensis* Masuda, 1952 (Masuda, 1952, pp. 252–253, pl. 24, figs. 4–7), is allied the present new species, but the former differs from the latter by having a larger apical angle, closely arranged and larger number of radial ribs, and fainter radial threads on the lower half of the shell of the left valve, and further, the interspaces between the radial threads in the former are narrower than in the latter. The surface of the right valve of Masuda's species is ornamented with closely arranged concentric growth lines while in the present new species they are hardly developed.

Remarks:—The distinction between the genus *Miyagipecten* and *Placopecten* has been discussed by Masuda (1952, pp. 251–252). The present new species somewhat resembles *Placopecten akihoensis* (Matsumoto), (Masuda, 1952, pp. 250–251, pl. 24, fig. 103), in possession of radial threads on the right valve, though they are hardly developed, and the radial threads on the left which are weakly developed marginally. However, the present specimens are referred to the genus *Miyagipecten* because the surface sculpture of the right and left valves are different.

Locality and Geological Formation:—Loc. 1, a road side cutting at the entrance of the Jyûroku-go valley, Chirai, Saroma-machi, Tokoro-gun, Hokkaido. The Chirai formation, Upper Miocene in a two hold division.

Repository:—Geological and Mineralogical Institute, Tokyo University of Education, Reg. Nos. 6195 (holotype), 6196 (paratype).

Patinopecten aff. *kobiyamai* Kamada, 1954

Plate 42, Figures 8–9.

Remarks:—An incomplete right and left valves were examined. Though the present specimens resemble Kamada's type species in the general features, some differences exist between them. Namely, the shapes of the ribs are closely similar, especially in that minor striations are developed in the interspaces of the radial ribs in the marginal part of the left valve, however, the number of radial ribs of the writers' specimens exceed those of the type species; there are more than nine radials in the left and right valves whereas there are only five or six radials on the type specimen. Considering the number of radial ribs, the present specimens seem to be a species different from Kamada's, and from general morphology, a descendant of that species. The present specimens resemble *Patinopecten kimurai* (Yokoyama), (Yokoyama, 1925, p. 27, pl. 4, figs. 1–6), but the former differs from the latter by having narrow radial ribs and more flattened shell of the left valve. Therefore, the present specimens may represent a new form, but the state of preservation does not permit establishing a new name.

Repository:—Geological and Mineralogical Institute, Tokyo University of Education, Reg. No. 6200.

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Explanation of Plate 42

Figs. 1-5: *Miyagipecten saromensis* HASIMOTO and KANNO, n. sp.
1. Right valve of a plaster-cast of the holotype. Reg. No. 6195.
2-5. Left valves of a plaster-cast of the paratype. Reg. No. 6196.

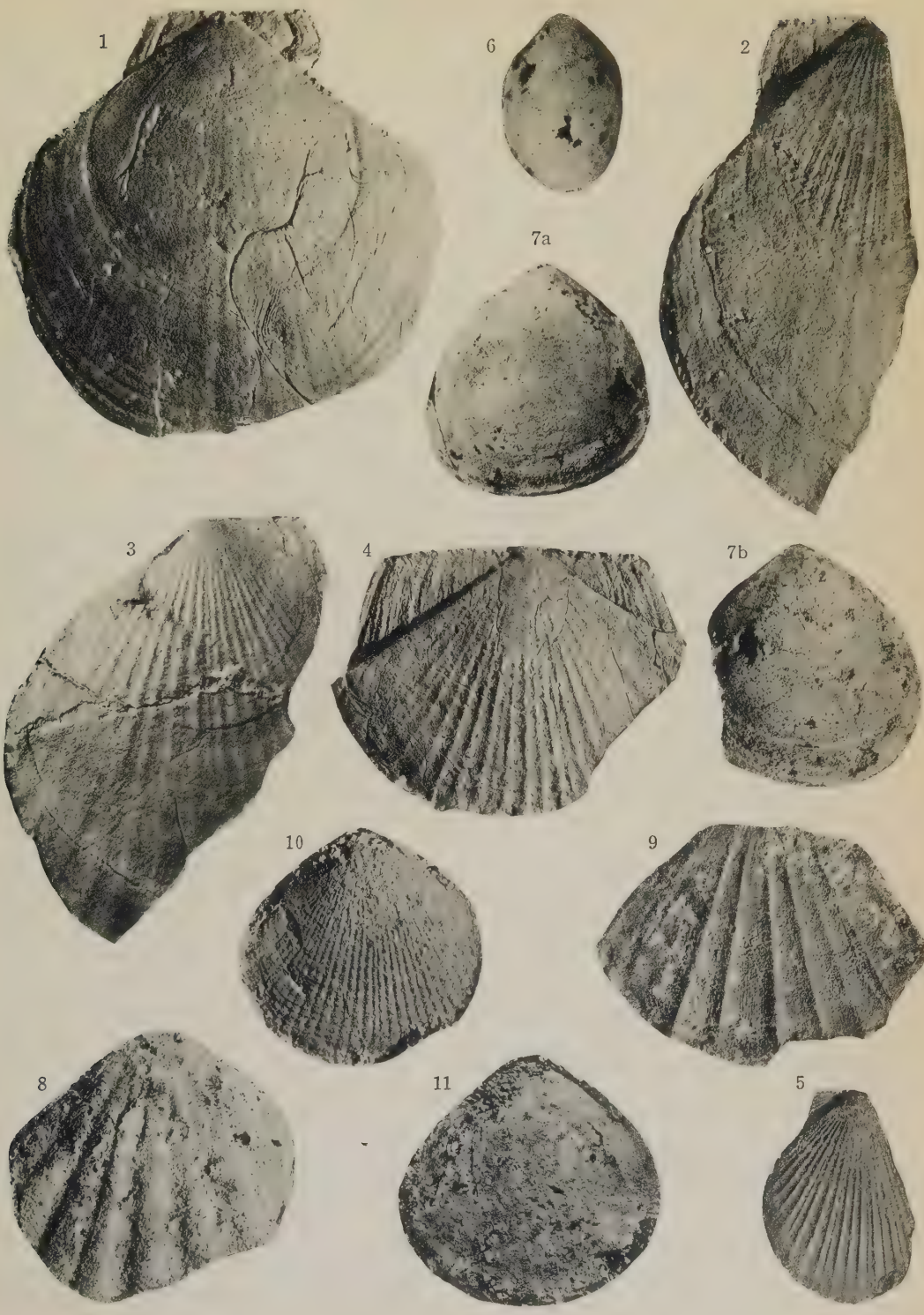
Fig. 6: *Crenella tomiyaensis* HATAI and NAKAMURA. Reg. No. 6199.

Figs. 7a-b: *Spisula* sp. indet. Reg. No. 6201.

Figs. 8-9: *Patinopecten* aff. *kobiyamai* KAMADA
8. Right valve. Reg. No. 6200.
9. Plaster-cast of a left valve, showing the external sculpture.

Figs. 10-11: *Glycymeris* cf. *idensis* KANNO
10. Plaster-cast of a right valve.
11. Inner mould of a right valve, showing the taxodont teeth, Reg, No. 6198.

All figures in natural size



S. Aoki photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 32, pp. 291-298, pl. 43, Nov. 10, 1958

350. LATE TRIASSIC *PALAEOPHARUS* IN JAPAN*

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本邦上部三畳系の *Palaeopharus*： 蝶番・内部構造等により，この属が Cardiniidae に属し，preheterodont と heterodont を結び付ける中間型である事が判明したので，この機会に新亜属 *Minepharus* と共に美祢統産の三種を記載し，尚系統発生的見地から所謂 pseudocardinal teeth を検討した。新亜属は系統発生的に最も初期の Cardiniidae の一型である。又河内ケ谷統より広く知られていた "*Pleurophorus*" *oblongatus* は美祢産の標本により *Palaeopharus* に属する事が判った。

徳山　明

Palaeopharus KITTL is an important member of the Upper Triassic faunas of Japan, e. g. the Kochigatani fauna at Sakawa and Sakuradani, the Nabae at Heki, Nabae and Kyowa and the Mine at Mine. It is often accompanied by *Minetrigonia* and "*Bakevellia*," and indicates the shallow water facies of an embayment, inland or open-sea. KOBAYASHI and ICHIKAWA (1951) were the first to find this genus in Japan at Nabae and Heki. Subsequently another 2 species and 2 varieties were added from Heki by KOBAYASHI and ICHIKAWA (1952), from Nabae by NAKAZAWA (1955) and from Kyowa by NAKANO (1957). Here the writer describes the following three forms from the Mine series:

1. *oblongatus* (KOBAYASHI and ICHIKAWA) which is widely known from Sakawa (KOBAYASHI and ICHIKAWA, 1950), Sakuradani (ICHIKAWA, 1954) and Mine (KATAYAMA, 1939), and was referred to *Pleurophorus*, but the Mine form proves its being a *Palaeopharus*.
2. *buriji* KIPARISOVA (1954) which was reported from Maritime Province of Siberia, may be a subspecies of *oblongatus*.
3. *Minepharus triadicus* TOKUYAMA represents a new subgenus, linking the so-called Triassic *Pleurophorus* (WAAGEN'S sense, 1907) with *Palaeopharus*.

Table 1. *Palaeopharus* in Japan.

Palaeopharus \ Area	Mine	Kochigatani	Sakuradani	Nabae	Heki	Kyowa
oblongatus (KOBAYASHI & ICHIKAWA)	*	*	*	-	-	-
oblongatus buriji KIPARISOVA	*	-	-	-	-	-
maizuruensis KOBAYASHI & ICHIKAWA	-	-	-	*	*	*
maizuruensis n. subsp. by NAKAZAWA	-	-	-	*	-	-
maizuruensis var. *imamurai* NAKANO	-	-	-	-	-	*
maizuruensis var. *flexicostatus* NAKANO	-	-	-	-	-	*
paucicostatus NAKAZAWA	-	-	-	*	-	-
(*Minepharus*) *triadicus* TOKUYAMA, n. sp.	*	-	-	-	-	-

See the Table for *Palaeopharus* in Japan. On this occasion the develop-

* Received March 22, 1958; read at the 67th Meeting of Palaeontogical Society of Japan, April 26, 1958 at Niigata.

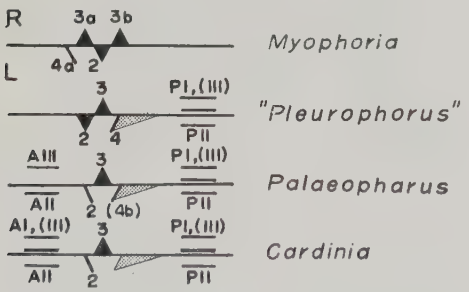
ment of the "pseudocardinal" teeth in the Triassic "schizodont" pelecypods is also discussed.

The writer is greatly indebted to Professor T. Kobayashi for his kind guidance and encouragement.

Hinge Development in the Triassic "Schizodonts"

The hinge apparati of the Triassic Schizodonts can be classified into the following groups:

1. True Schizodonts or *Myophoria* group including *Trigonodus, Pachycardia, Heminajas, Myophoria* and *Minetrigonia.*
2. Pre-Heterodonts
   - 2A. "*Pleurophorus*"* group including "*Pleurophorus*" and *Cardinioides.*
   - 2B. *Cardinia* group including *Palaeopharus, Isopristes* and *Cardinia.*



Text-figure 1. Hinge arrangement of pre-heterodonts and schizodonts.

* As Cox pointed out (Marwick, 1953), the generic name, *Pleurophorus* King (1844), is preoccupied by *Pleurophorus* Mulsant (1842), a scarab Coreoptera (Schurtze, Kückenthal und Heider, 1935). Chavan 1954) proposed *Permophorus* for its substitute, but it is open to question whether *Permophorus* is valid or not, because *Pleurophorella* Girty (1904) or *Pleurophorina* Licharew (1925) may be its synonym (Newell, 1940, 1957). For the time being the writer uses "*Pleurophorus*" for the pelecypod genus in question.

The first group is the true schizodont in which one triangular median tooth 2 exists on the left valve, and the dental arrangement is as shown in fig. 1. In the second group, the triangular median tooth is seen on each valve (3 and 2) and tooth 3a becomes obsolete. According to Chavan (1954, in Newell, 1957) the hinge formula of "*Permophorus*" is 2, (4b), PII—(3a), 3b, PIII, but Newell could not confirm the existence of the tooth 3a in the American "*Permophorus*". As shown in the above formula, posterior lateral teeth are developed in this group. Another Permian genus *Celtoides* Newell (1957) has 2, (4b), PII in the left and 3b, (PI), PIII in the right valve. Triassic *Cardinioides* Kobayashi and Ichikawa (1952) has the same kind of hinge, although its cardinal is a pseudocardinal. In the third group the tooth 2a becomes obsolete and 4 is separated from the nymph in some forms; laterals are developed in the anterior as well as in the posterior part, although anterior laterals are insignificant in some primitive forms. The so-called pseudocardinals are often seen in the three groups. In the first group the tooth 2 (or 2b) is crenulate as in *Trigonodus* and *Pachycardia.* The Unionidae belong to this group in which the position of pseudocardinals is variable. In the 2A group the left cardinal tooth takes the aspect of the pseudocardinal as in *Cardinioides.* In the 2B group it is not a cardinal but a lateral tooth. Kobayashi and Ichikawa (1951) emphasized the resemblance of the pseudocardinal tooth between *Unio* and *Palaeopharus*, but the resemblance may be superficial, because the pseudocardinal in unionids is really a kind of cardinal tooth, while in *Palaeopharus* it is generated from an anterior lateral tooth. The writer thinks that the presence or

absence of a "pseudocardinal tooth" is not so essential for the pelecypod classification as they are evaluated. *Palaeopharus* should be separated from *Unio*-group which is perhaps a descendant of the *Myophoria* group. The three groups are all closely allied in the muscle scars and ligament characters, although their hinge apparati are different genetically. The oldest is the *Myophoria* group from which the "*Pleurophorus*" group was presumably derived in the Carboniferous; subsequently the *Cardinia* group from the second group in the late Triassic period and attained its acme in the Jurassic. This is the link between the "pre-heterodonts" and the true heterodonts which the latter flourished in the late Mesozoic and Cenozoic. It is interesting to see a transitional form between the "*Pleurophorus*" and *Cardinia* groups in the Mine collections; *Minepharus*, new subgenus, may be the most primitive and earliest member of the *Cardinia* group.

Description of Species

Superfamily Cardiniacea

Family Cardiniidae Zittel

Genus *Palaeopharus* Kittl, emend. Kobayashi and Ichikawa

1907: *Palaeopharus* Kittl, *Rept. Norweigian Arctic Expedition, 1898-1902, no. 7*, p. 34.

1914: *Pleurophorus*, Böhm *Jb. K.K. Preuss. G. L-A., Bd. 35*, S. 556.

1951: *Palaeopharus* Kobayashi and Ichikawa, *Tr. Proc. Pal. Soc. Japan, N.S., no. 1*, p. 7.

Diagnosis:—Shell elongated to subelliptical; umbo prosogyrous, located at anterior a fourth or so; lunule distinct, striated by growth lines; ligament opisthodetic, external and supported by well defined nymphs in anterior half of shell; area fairly large, elongated and striated transversely by growth lines. Anterior addctor scar stout, strongly impressed; posterior one larger and less distinct; pedal retractor scar very deep, just behind anterior adductor scar. One cardinal tooth (3b) on right valve and two (2b and 4b) on the left; one posterior lateral tooth on each valve strong and massive. Anterior lateral tooth wide and its groove finely crenulate and pseudocardinal-like. Ornament variable; test smooth or concentrically striated and often radially costate.

Remarks:—Böhm (1914, S. 556) considered *andersoni* to be a *Pleurophorus* but *andersoni* as well as Japanese species of *Palaeopharus* are separable from "*Pleurophorus*" King in the generic rank as Kobayashi and Ichikawa pointed out. They laid stress on the pseudocardinal tooth in this genus. In the typical *maizuruensis* from Nabae and Heki, it looks like a cardinal tooth and similar to a pseudocardinal in *Unio*. Nakazawa (1955) noticed extensive variation in its shape and called it a "pseudocardinal area" which does not mean a tooth, because the area in each valve does not interlock each other. In the Kyowa specimen, (Nakano, 1957, pl. 9, fig. 11), the "pseudocardinal" tooth is elongated and parallel to the inner margin of a lunule and crenulation seen on groove which separated the tooth or a "lateral" from the margin. In *Minepharus*, new subgenus, the lateral tooth is primitive and separated from the margin by a shallow groove which is non-crenulate. The Mine and Kyowa specimens suggest that the so-called pseudocardinal tooth in *Palaeopharus* is merely a variant from the primitive lateral tooth. On the other hand *Unio* bears the hinge

apparati of *Myophoria*-type. Its pseudocardinal is a kind of cardinal tooth and the crenulate tooth on the right valve interlocks with the crenulate socket on the left valve. Therefore, so far as the "pseudocardinal" is concerned, *Palaeopharus* is essentially different from *Unio* and the resemblances are superficial.

According to Newell (1957) Permian "*Pleurophorus*" has the following characters*:

Lunule and escutcheon well developed, ligament opisthodetic and parivincular, supported by well defined nymphs which are limited to the anterior one-fourth of the dorsal margin; dentiton consisting usually of one postero-lateral tooth (PIII) in the right valve along the shell margin which passes over a single lateral (PII) of the left valve; one cardinal tooth in each valve, that of the right (3b) passing above that of the left (2); rarely, there is an additional poorly developed, inner postero-lateral tooth (PI) and an outer cardinal (4b) in left valve of a few individuals.

This agrees with Permian "*Pleurophorus*" in the characters of lunule, escutcheon, ligament, nymph and hinge arrangement, but the teeth 2 and 4a and nymph are more developed in this than in that genus. The tooth 2 is very small and elongated in this, while it is a triangular boss of moderate size in "*Pleurophorus*". Furthermore, umbones are pointed a little more posteriorly in it than in "*Pleurophorus*". *Triaphorus* Marwick (1953) from the Upper Triassic of New Zealand agrees with this in cardinal teeth, nymph and posterior lateral tooth, but an invaluable distinction is the absence of the "*pseudocardinal*" in Marwick's. The hinge apparati of the Upper Triassic "*Pleurophorus*" *curionii* Bittner disagree with those of Palaeozoic "*Pleurophorus*" s. str. (Böhm, 1914). Bittner's may be congeneric with Marwick's. Jurassic *Kalentera* Marwick (1953) is also a relative of *Triaphorus*. *Kalentera* appears to be related to *Myoconcha* rather than *Palaeopharus*. After all, *Cardinia* Agassiz may be the closest ally to *Palaeopharus*, although Agassiz's is distinguishable from this by its surface ornament and anterior lateral tooth. The two genera are so closely related in interior and ligament characters that they belong to the same family. More precisely, they have similar arrangement and shapes of cardinal, posterior lateral teeth and equally large and elongated ligament area. Moreover, in *Minepharus*, a new subgenus of *Palaeopharus*, the anterior lateral groove is not crenulate and the lateral is though small, similar to the one in *Cardinia*. The strong muscular impressions and entire pallial line are the features common between the two genera. Therefore, *Palaeopharus* must be referred to the Cardiniidae.

Palaeopharus oblongatus (Kobayashi and Ichikawa)

Plate 43, figures 8–11.

1939: *Pleurophorus* cfr. *perlongatus* Böhm by Katayama, *J. Geol. Soc. Japan, vol. 46*, p. 381 (listed).

1950: *Pleurophorus oblongatus* Kobayashi and Ichikawa, *J. Fac. Sci. Univ. Tokyo, sec. 2, vol. 7*, p. 212, pl. 1, fig. 10.

1954: *Pleurophorus* cfr. *oblongatus* Ichikawa,

* King (1850) illustrated two prominent cardinal teeth in each valve and a marginal lateral tooth in the left valve, but Böhm (1914) and Newell (1940) pointed out his erroneous observation. Its dental formula is 2, (4b), PII–(3a), 3b, PIII according to Chavan (1954).

J. Inst. Polytech. Osaka City Univ., vol. 1, no. 1, p. 40.

Description:—Shell three to four times as long as high; umbo subterminal, anterodorsal margin almost straight; anterior part roundly trigonal; dorsal and ventral margins almost straight and parallel in median part; posterior margin more gradually rounded than anterior. Lunule small and triangular; ligament opisthodetic, external; ligament area elongated, and striated transversely by growth lines. Anterior adductor scar ovate, strongly impressed; posterior one subrounded, large and less distinct than anterior one; pedal retractor scar small and pitted, just behind anterior adductor. Pallial line entire. Left hinge consists of a cardinal (3b), "pseudocardinal" and posterior lateral tooth; 3b welded to an elongated nymph. Right hinge consists of a triangular cardinal tooth (2) and a socket just posterior to 2. "Pseudocardinal" wide, and corresponding to one on the left valve, but they are not interlocked with each other; they are so to speak "cardinal areas". Surface ornamented with concentric lines of growth; radial markings weak and found on posterior area, if present.

Measurement in mm.	Length	Height
Left valve	70.5	20.4
Right internal mould	44.5	19.3
Immature shell	34.5	10.8

Observation:—Due to the secondary erosion no pseudocardinal is preserved in the Kochigatani specimens. A "pseudocardinal" tooth is, however, well developed and resembles *Unio's* superficially, but they are genetically quite different. In some specimens no radial marking is present, but others have 3–4 very weak angular and widely spaced ribs. The latter may be no more than varietal forms. The anterior portion is a little acuter in the Mine form than in the typical Kochigatani form.

Comparison:—The Mine form is indistinguishable from the typical form if the pseudocardinal is not preserved, because the two forms are similar in the outline, muscular scars, pallial line, ligament features and in the hinge apparati, especially in the anterior hinge area. They are almost identical in the general outline and surface ornaments. The preservation of the typical form in coarse sandstone suggests that the "pseudocardinal" is eroded out in the holotype. Therefore the writer thinks that "*Pleurophorus*" *oblongatus* should be referred to *Palaeopharus*. Carnic *Palaeopharus buriji* Kiparisova from Maritime province of Far East may be conspecific with this. According to her (1954, p. 44) the surface is feebly marked by radial striae. Faint radial striae and pseudocardinals are sometimes recognizable also in this species. That form differs from this in the more anteriorly pointed umbo and more inflated posterior outline, but the difference may be within the limits of a species. The range of variation is often very large in such shallow water or brackish water molluscs. From *maizuruensis* and *andersoni* it is easily distinguishable by the absence of distinct costae.

Occurrence:—Abundant in the whole Hirabara stage of the Mine series at Mugikawa, Shiraiwa, Hirabarazaka, Hirabara, Okubata, Sugiwara and north of Shirogawara. Rare in the Aso stage at Sonose. Ecologically the shell is most common in the transitional zone from bituminous embayment to the open-sea facies. Sometimes it forms shell banks with "*Bakevellia*" and *Minetrigonia*. This species inclusive of the Kochiga-

tani and Siberian forms is very widely distributed in northeastern Asia in the Carnic age.

Palaeopharus oblongatns buriji Kiparisova

Plate 43, figure 12.

1954: *Palaeopharus buriji* Kiparisova, *Field illustrated hand book* etc., p. 44, pl. 34, figs. 5, 6.

Characterized by very weak pseudo-radial striae in postero-dorsal area. The striae are widely spaced, angulated on the top and crossed by concentric lines of growth. The posterior outline is slightly more inflated in Siberian (Kiparisova, fig. 5) than the common Mine form. Hinge normal for *Palaeopharus*.

Occurrence:—Common in sandstone of the upper Hirabara formation and middle Aso formation (mid.- up. Carnic) and upper Carnic of Maritime Province of Siberia (T_3^1 of Kiparisova).

Subgenus *Minepharus* Tokuyama, new subgenus

Type species:—*Palaeopharus* (*Minepharus*) *triadicus* Tokuyama, new subgenus and species.

Diagnosis:—Shell elongated, elliptical, a little compressed, and slightly tapering anteriorly; umbo prosogyrous, at a fourth from anterior extremity; ligament opisthodetic, subinternal; ligament area triangular and depressed; lunule small but distinct. Internally, anterior adductor scar very strong; posterior one subcircular, larger and less distinct than anterior; pedal retractor scar small, prominent. Pallial line entire. Hinge consists of a right and two left cardinals, and a lateral tooth in anterior and posterior. Tooth 2b not clearly separated from margin of lunule; 4b elongated, slender and welded to a depressed triangular nymph; a socket 3b′ deep, fairly short. Socket PI′ profound and remarkable. PIII less distinct than PI. A narrow-furrow divides anterior lateral (AIII). Ornament consists of stout pseudo-radial costae and concentric lines of growth.

Remarks:—In this subgenus the anterior cardinal 2b, is not so remarkable as "*Pleurophorus*" in which, according to Böhm and Newell 2b is stout and triangular; posterior cardinal 4b slender but distinct in this subgenus, while in Permian "*Pleurophorus*" it is not separated from the nymph. Waagen (1907), however, described 2b, 4b and 3a of "*P.*" *curionii* from Seiser Alm. Therefore, except for its rudimentary anterior lateral, it agrees with Triassic "*Pleurophorus*". This rudimentary lateral is developed into a pseudocardinal of *Palaeopharus*. Therefore the presence of the anterior lateral groove is an important distinction of *Palaeopharus* from "*Pleurophorus*"; the groove is crenulate in *Palaeopharus* (s. str.), but non-crenulate in *Minepharus*. If it is crenulate, there is no distinction of this subgenus from the typical *Palaeopharus*. The writer opines that "pseudocardinal" of *Palaeopharus* is derived from the lateral tooth ontogenetically. This subgenus is closely related to *Cardinia* in the musculature and hinge, although the anterior lateral is a little weaker in the former than the latter. They agree with each other in the arrangement of cardinal teeth, elongate-trigonal nymph and massive lateral teeth, general feature of hinge area, prominentopisthodetic and external ligament, stout muscular impression and pallial line. Thus "Pleurophoridae" are linked with the Cardiniidae by this subgenus.

Cardinia is said to be related to

Trigonodus (Waagen, 1907), but its hinge is neither of *Trigonodus*- nor *Myophoria*-type, and agrees with that of *Palaeopharus*, especially this subgenus. Therefore *Minepharus* is a primitive form of the Cardiniidae.

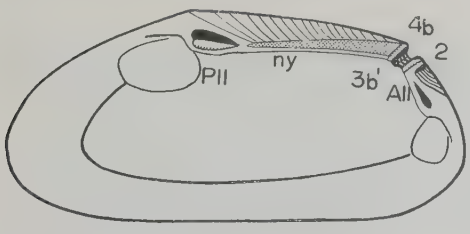
Species:—*P.* (*Minepharus*) *triadicus*, monotypic.

Distribution:—Carnic; Japan.

Palaeopharus (*Minepharus*) *triadicus* Tokuyama, new subgenus and new species

Plate 43, figures 1-7; text-figure 2.

Description:—Shell moderate in size, but small for *Palaeopharus*, elongated, elliptical, a little compressed and slightly tapering anteriorly; umbo prosogyrous, at a fourth from anterior extremity; hinge line a little longer than a half of shell; ligament opisthodetic, external; ligament area wide, distinct, located near middle and transversely striated



Text-figure 2. *Palaeopharus* (*Minepharus*) *triadicus*.

by growth lines. Lunule small but distinct. Hinge and other interior characters of *Minepharus*. Surface covered with several stout and rounded pseudoradial costae on dorsal side. They begin in the earliest stage and become stout and widely spaced. Growth striae fairly strong, concentric and somewhat irregularly.

Measurement in mm.	Length	Height
Holotype (Left)	50.5	21.4
Paratype (Right)	45.3	15.0
varietal form (Left)	45.5	21.2
variatal form (Right)	24.6	17.0

Observation:—A small and rounded prodissoconch is preserved in an immature shell (fig. 5). In the subsequent stage the radial rib starts on the posteroventral side where it is originated from the concentric rib or striation. This concentric line curves down to the posterior corner and develops into a radial rib. The same process of costation was found by Böhm (1903) in *andersoni*. The umbo lies at or near the middle in the juvenalium, but is slightly anteriorly in later stages of growth. A varietal form (fig. 4) is very short. Its internal mould closely resembles that in *Cardinia*.

Comparison:—This species is shorter than *Palaeopharus* and resembles *Cardinia* in outline. Except for radial costae this is closely related to *Cardinia*, both internally and externally. The surface ornamentation of this species is similar to those of *Palaeopharus andersoni*, *P. perlongus*, "*Pleurophorus*" *curionii* and Palaeozoic "*Pleurophorus*" *radiatus*. From all of them, however, this is easily distinguishable by its hinge apparati. It is a linking form between the so-called Triassic "*Pleurophorus*" and *Palaeophorus* and also between *Palaeophorus* and *Cardinia*; the earliest member of *Cardinia* is coexistent with this.

Occurrence:—Common in the transitional zone from the inland to open-sea facies of the middle Hirabara stage (low. Carnic) at Hirabarazaka, west of Omine, Mine in Nagato.

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Explanation of Plate 43

Figs. 1- 7: *Palaeopharus* (*Minepharus*) *triadicus* TOKUYAMA, new subgenus and new species 297

1: Holotype, left valve; 2-7: paratypes; 2,4: short varieties; 5: immature left valve showing prodissoconch, ×3; 6, 7: internal moulds of both valves showing hinge and interior. Loc. Hirabarazaka, west of Omine, Mine city, Prov. Nagato.

Figs. 8-11: *Palaeopharus oblongatus* (KOBAYASHI and ICHIKAWA) 294

8: Internal mould of immature left valve, showing hinge apparatus. Loc. West of Hirabara, Mine city.

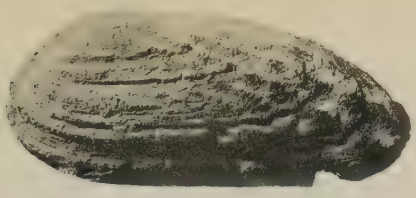
9: Elongated form. Loc. Hirabarazaka; 10: surface of left valve, loc. ditto.

11: a: right internal mould showing hinge apparatus and interior; b: clay cast of the same specimen. Loc. ditto.

Fig. 12: *Palaeopharus oblongatus buriji* KIPARISOVA 296

External clay cast showing weak ribs in the posterior area. Loc. North of Omine in Mine.

All figures except fig. 5 are in natural size. All specimens illustrated here are deposited in the Geological Institute, University of Tokyo.



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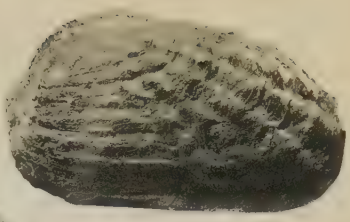

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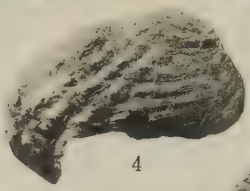

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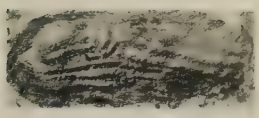

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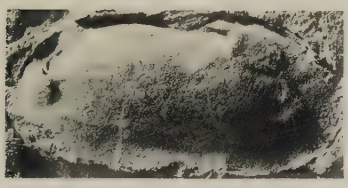

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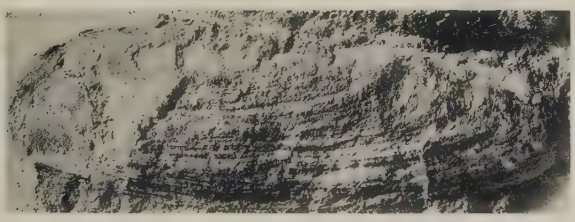

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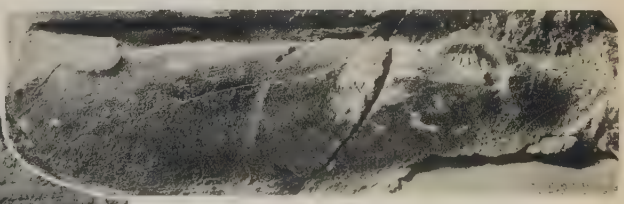

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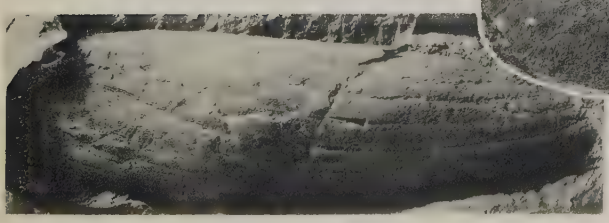

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 32, pp. 299-304, pl. 44, Nov. 10, 1957

351. AN INTERESTING CRUSTACEAN REMAIN, *CTENOCHELES SUJAKUI* N. SP. FROM THE PALEOGENE OF KYUSHU, JAPAN*

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九州古第三紀産あなじゃこ科 *Ctenocheles sujakui* n. sp.: 佐賀県小城郡南多久村長尾西端三菱古賀山鉱業所 11 号井，深度 249.68 m および 309 m の芦屋層群杵島層から朱雀智介により採集された *Ctenocheles sujakui* n. sp. を記載した。その系統的子孫にあたる現生種は中村正吉により柏崎沖の大洲から採集され，岸上鎌吉により報告されており，relict である。

本種はその形態に特徴があり，化石の破片でもわかりやすく，地質学にやくだつものと思われる。GLAESSNER が Victoria の始新世より *Ctenocheles victor* を 1947 年に報告している。　今泉力蔵

The crustacean remains here described, were collected from the Kishima formation in the boring cores of the Well, No. 11 of the Kogayama Coal Mines, Nagao, Minami-Taku-mura, Ogi-gun, Saga Prefecture by Mr. Tomosuke SUJAKU of the Mitsubishi Mining Company and were submitted to the writer with other remains of a new genus of the Goneplacids. They proved to be a very rare genus of the Family Callianassidae, of which descendant is a relict in the Japan Sea, *Ctenocheles balssi* KISHINOUYE, 1926.

Although the *Ctenocheles* remains are fragmentary, they have some importance from the stratigraphic view point by their well-defined characters.

The writer is indebted to Messrs Tomosuke SUJAKU and Yôichiro MORINAGA, Yasuhiro KAMADA and Toshio KIHARA for kindly placing the fossil specimens of the Crustacea at his disposal. He is also grateful to Emeritus Professor Hisakatsu YABE, Professors Shôshiro HANZAWA and Kiyoshi ASANO of the Institute of Geology and Paleontology of Tohoku University, Professor Kotora HATAI of the Department of Geology, College of Education, Tohoku University and Professor Kenzo YAGI of the Institute of Earth Sciences, College of Arts and Sciences, Tohoku University for their continuous encouragements.

* Received April 6, 1958; read at the 55th Meeting of the Palaeontological Society of Japan, Oct. 10, 1955, at Sendai.

Description

Tribe Thalassinidea

Family Callianassidae

Genus *Ctenocheles* KISHINOUYE, 1926

KISHINOUYE, K., 1926, Two Rare and Remarkable Forms of Macrurous Crustacea from Japan, *Annot. Zool. Japon., Vol. 11*, pp. 63-66, Fig. 1.

GLAESSNER, M. F., 1947, Decapod Crustacea (Callianassidae) from the Eocene of Victoria, *Proc. Roy. Soc. Victoria, Vol. LIX*,

(*New Series*), *Par. 1*, pp. 4-7, Pl. 1. Figs. 8 and 9, Text-fig. 1.
Genotype: *Ctenocheles balssi* Kishinouye.

In his description of *Ctenocheles victor* from the Eocene Rivernook House, on the coast about one and a quarter miles southeast of the mouth of the Gellibrand River, Victoria, M. F. Glaessner has already stated that *Ctenocheles* was established for a living Thalassinid corresponding in essential features with *Callianassa*, but distinguished by the excessive development of the right chelliped, which resembles that of the lobster-like deep-sea Decapod *Thaumastocheles*. Specimens of *Thaumastocheles japonicus* Calman are collected from depth of about 400 m, of the Sagami Bay, Shizuoka Prefecture and Kumanonada, by dragnets.

Only a right cheliped of this species was collected by Doflein from Japanese waters and was described by Balss as ? *Pentacheles* nov. sp. Therefore, the specific name of the genotype was denominated as *balssi* by Kishinouye.

The genotype, *Ctenocheles balssi* Kishinouye was collected at Ôsu, near Kashiwasaki, Niigata Prefecture. This specimen, measuring 10 cm in length, is female, and is more or less mutilated. This deep water dweller is blind. Any other specimen of Recent species has never been known to be collected thereafter.

M. F. Glaessner included *Ischnodactylus* (*Ischnodactylus cookei* Rathbun, 1935; *Ischnodactylus cultellus* Rathbun, 1935; *Ischnodactylus? dentatus* Rathbun, 1935) from the Paleocene and Eocene of Alabama and Mississippi and *Thaumastocheles rupeliensis* Beurlen, 1939 from the Middle Oligocene of Hungary, in the genus *Ctenocheles*. The incomplete chelipeds of *Thaumastocheles rupeliensis* Beurlen, 1939 possess distinctive features of *Ctenocheles*. K. Beurlen drew attention to their striking resemblance to the cheliped described by Balss as *Pentachles* sp.?

The fragmentary hands and fingers of *Ischnodactylus* also correspond with *Ctenocheles* in their shape and weak ornamentation, though the denticulation of most of these fingers is incompletely preserved. It should be noted that their identification with *Ctenocheles* does not affect other species of *Ischnodactylus*, *Ischnodactys macrodactylus* (Schlüter) and *Ischnodactylus esocinus* (Fritsch), in which long spiny claws are associated with lobsterlike remains of the carapace or abdomen. Long fingers with long pointed teeth are observed in more than one family of Decapod Crustacea, but the shapes of ornamentation of the hand and fingers make it possible to distinguish them.

Ctenocheles has an asymmetrical and unequal first pair of the pereiopod and very specialized large cheliped. The only specimen of the genotype, *Ctenocheles balssi* has first pereiopod, of which the right one is larger than the left and is specialized in the shape of the finger like a comb.

Syntype No. 1, the manus with the fixed finger of the present species of the *Ctenocheles* is determined as the right one, by the swelling of both surfaces of the manus and the vertical furrow behind the articulation with the dactylus of one surface. The surface with a vertical furrow behind the articulation with the dactylus, is inner one and therefore the manus is determined as the right one by the orientation of the inner surface of the manus. This right manus of the present species of the *Ctenocheles* (syntype No. 1), belongs to the smaller cheliped of the first pair of the pereiopoda. The other four syntypes

of the present species of the *Ctenocheles*, (syntypes, No. II–V), are isolated, long, thin and denticulated fingers. They are no doubt belong to the larger one of the first pair of the pereiopoda. The left manus (syntype No. VIII) of the present species is larger type.

It is not always the case that in the same taxonomic unit of Crustacean Decapoda, the one cheliped, whether it is right or left, is longer than the other. Though it has never been assured in the living or fossil species as the *Ctenocheles*, have commonly asymmetrical chelipeds especially in the male. The present species of the *Ctenocheles* has the left larger cheliped, while the known specimens of *Ctenocheles victor* and *Ctenocheles balssi*, have the right larger chelipeds.

Ctenocheles sujakui n. sp.

Plate 44, figures 2–5.

Based on the right manus with the fixed finger (syntype No. I), four fragmental fingers (Syntypes No. II–V) of the larger chela (perhaps, left one), the right immovable finger of the second pereiopod (syntype No. VI), the fragmental posterior part of the chela (syntype No. VII), and the anterior part of the left manus with the stump of the fixed finger (syntype No. VIII).

Palm of the right manus elongate about one and a fifth times as long as high; swollen, thickness half of the width; superior border blunt, almost straight but gently swelled in the middle part; inferior border also blunt, but thinner than the superior; raised and swollen in the middle and the posterior part, with 7–8 pits along the inferior margin. A vertical furrow behind the articulation with the dactylus on the inner surface is broad and shallow. Numerous irregularly polygonal pavements apparently belonging to the lower layer cover the whole surface except the distal portion. Manus of the left chela, decorticated, outer surface covered with polygonal pavements; palm much swollen; proximal end lacking; articulating condyle with the movable finger is large; the immovable finger is strongly deflexed.

Fixed finger imperfectly preserved, perhaps shorter than the palm, and oval in cross section at the base, with blunt and imperfectly preserved teeth along the prehensile edge. Fingers of the large chela very thin, platy and long attenuate abruptly in the distal part, with regularly alternating longer and shorter pointed teeth; longer teeth of the finger are regularly spaced and gradually shorten their length to the anterior part of the finger, the posterior part and the base of the finger unknown; between the longer teeth about three or four shorter teeth arranged, in these shorter teeth there are differences in length, and the one near the longer teeth shorter than the others; the curvature of the teeth slightly directed backwards in most cases; the distal ends of the teeth curved. The base of the right immovable fingers, (syntype No. VI) showing the inner superior surface with the ill-preserved small teeth along the prehensile edge, perhaps smaller chela of the second pereiopod. The fragment of the posterior part of the manus (syntype No. VII), perhaps belongs to the left larger chela of the first pereiopod, covered with irregular pavements.

Dimensions:—Manus (syntype No. I); length of palm: 16.5 mm; width of palm at distal part: 11 mm, maximum width in the middle part of palm: 14 mm, width of proximal part of palm: 12.5 mm; thickness of palm: 6.8 mm; length of fixed finger: 10 mm; basal section of

fixed finger: 2.5 mm×1.8 mm.

Fingers (syntype No. II); length, 29 mm+, width, 2.5 mm±; (syntype No. III); length, 26 mm+, width, 2.5 mm±; syntype No. IV, length, 20 mm+, width, 3 mm±; syntype No. V, length, 11 mm+. Distances between the longer teeth, 5 mm and 5.8 mm in syntype No. II at the anterior part; 4.2 mm and 5 mm in syntype No. III at the anterior part, the distances between the longer teeth become longer forward. (syntype No. VII); fragment of the posterior part of the manus of the left larger chela, width, 8.5 mm+, length, 14 mm+. (syntype No. VIII); the left manus, the width of the anterior part, 12–13 mm; section of the stump of the immovable finger, height, 2.7 mm, width, 0.7 mm.

Geological Horizon, Locality and Repository:—Kishima formation, Ashiya group; from the boring core of the well, No, 11 of the Kogayama Coal mines, Mitsubishi Mining Company, at the western extremity of Nagao, Minami-Taku-mura, Ogi-gun, Saga Prefecture*; IGPS loc. no. Sa-002; lat. 33°17′18″ N., long. 130°7′ E., T. Sujaku coll., 1953, syntype No. I, sample number of the boring core No. 59, 249.6 m in depth, dark siltstone, IGPS coll. cat. no. 79567; syntypes No. II–VII, sample number of the boring core no. 68, 309 m in depth, dark siltstone, IGPS coll. cat. no. 79568. Syntype No. VIII, without sample number of the boring core, but seems to be near to No. 68, syntypes No. II–VIII, 309 m in depth, dark siltstone, IGPS coll. cat. no. 79568, with a molluscan fragment (*Crassatellites*? sp.).

Remarks:—*Ctenocheles victor* is larger in size comparing with *Ctenocheles sujakui*, the length of the finger of *Ctenocheles victor* is more than 14 mm and the length of its long teeth are over 2 mm and the length of its short teeth are less than 1/2mm, while the length of the anterior part of the finger of *Ctenocheles sujakui* is more than 29 mm and the length of its long teeth are over 2mm and the length of its short teeth are less than 1 mm. Morphologically they resemble very much, but the specimen of the finger figured by M. F. Glaessner in his figure 9, Plate I, (M. W. G. K. No. 1925) shows the long teeth bending slightly forward and the long teeth of the fingers of the large chelipeds of *Ctenocheles sujakui* leaning slightly backward, except the anterior long teeth of the syntype No. II.

Ctenocheles sujakui resembles closely to the living *Ctenocheles balssi*, but differs from the latter by the robust shape of its finger, and by the shorter palm of the smaller cheliped of the first pereiopod.

Ischnodactylus cultellus Rathbun, 1935 is described by the two specimens as follows, the one is the dactylus of the left cheliped, holotype (this specimen is mistaken for the right one by M. J. Rathbun, in the description, p. 14, but stated as the left one in his explanation of the figure, p. 139), preserved in the Alabama Museum of Natural History, from the Eocene Sucarnoochee formation at Estelle, Wilcox County, Alabama and the other is the right propodal finger, paratype, preserved in the John Hopkins University from the lower Eocene at Dry Creek, Jackson, Hinds County, Mississippi. These two specimens are also smaller type. Among these two specimens, paratype, the right propodal finger is 8.6mm in length (end lacking), 1.4 mm in height at articulation, 0.5 mm in width of the teeth. The propodal finger of the left smaller chela, (syntype,

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No. I), of *Ctenocheles sujakui* is more robust than the propodal finger of the right smaller chela of *Ischnodactylus cultellus*. *Ischnodactylus cookei* Rathbun, 1935 is collected from the Eocene Sucarnoochee formation, Midway in Prairie Creek region, Wilcox County, Alabama (holotype and paratype) and from the Sucarnoochee formation, Estelle, Wilcox County, Alabama (other specimens), the type locality of *Ischnodactylus cultellus*. The specimens of *Ischnodactylus cookei* are the right manus only, which belongs probably to larger cheliped. It is more smooth in its surface and smaller than *Ctenocheles sujakui*. The larger cheliped of *Ctenocheles sujakui* is easily distinguished from *Ctenocheles cultellus* by its larger articulating condyle with the movable finger.

Ischnodactylus (?) *dentatus* Rathbun, 1935 are composed only of the right propodal fingers and collected from the same locality as the other specimens of *Ischnodactylus cultellus* Rathbun, Dry Creek, Hinds Country. These three species of *Ischnodactylus*, *Ischnodactylus cultellus*, *Ischnodactylus cookei*, *Ischnodactylus* (?) *dentatus* may actually represent the different part of the same species, respectively, the dactylus and the propdal fingers of its left smaller cheliped, the manus of its right larger cheliped and the right propodal finger of its larger cheliped.

The incomplete chelipeds from the Middle Oligocene (Kisceller Tegel) of Obunda near Budapest, Hungary which K. Beurlen (1939) described as *Thaumastocheles rupeliensis* possess the distinctive features of *Ctenocheles*, but *Ctenocheles sujakui* is easily distinguished from the preceding species by the large number of the short teeth of the finger. The living Australian *Ctenocheles collini* M. Ward seems to be very robust.

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Explanation of Plate 44

Fig. 1. *Ctenocheles balssi* Kishinouye, collected at Ôsu, near, Kashiwasaki, Niigata Prefecture, reproduced from Fig. 1 of Kishinouye's paper, nat. size.

Figs. 2-4. *Ctenocheles sujakuni* n. sp., Kishima formation and Ashiya group, from the boring core of the Well, No. 11 of the Kogayama Coal mines, Mitsubishi Mining Company, at the western extremity of Nagao, Minami-Taku-mura, Ogi-gun, Saga Prefecture, T. Sujaku, coll., 1953, syntype No. I, sample number of the boring core No. 59, 249. 6m in depth; syntypes No. II-VII, sample number of the boring core No. 68, 309m in depth; syntype No. VIII, without sample number of the boring core, but seems to be near to No. 68, with a molluscan fragment (*Crassatellites ?* sp.).

Fig. 2. Syntype No. I, right manus with the fixed finger, external view, × 8/3.

Fig. 2a. Manus of the same specimen as fig. 2, external view, × 7/3.

Fig. 2b. Manus of the same specimen as fig. 2, internal view, × 7/3.

Fig. 2c. Manus of the same specimen as fig. 2, internal view, × 5/2.

Fig. 2d. Manus of the same specimen as fig. 2, internal view, × 12/5.

Fig. 2e. Fixed finger of the same specimen as fig. 2, upper view, × 12/5.

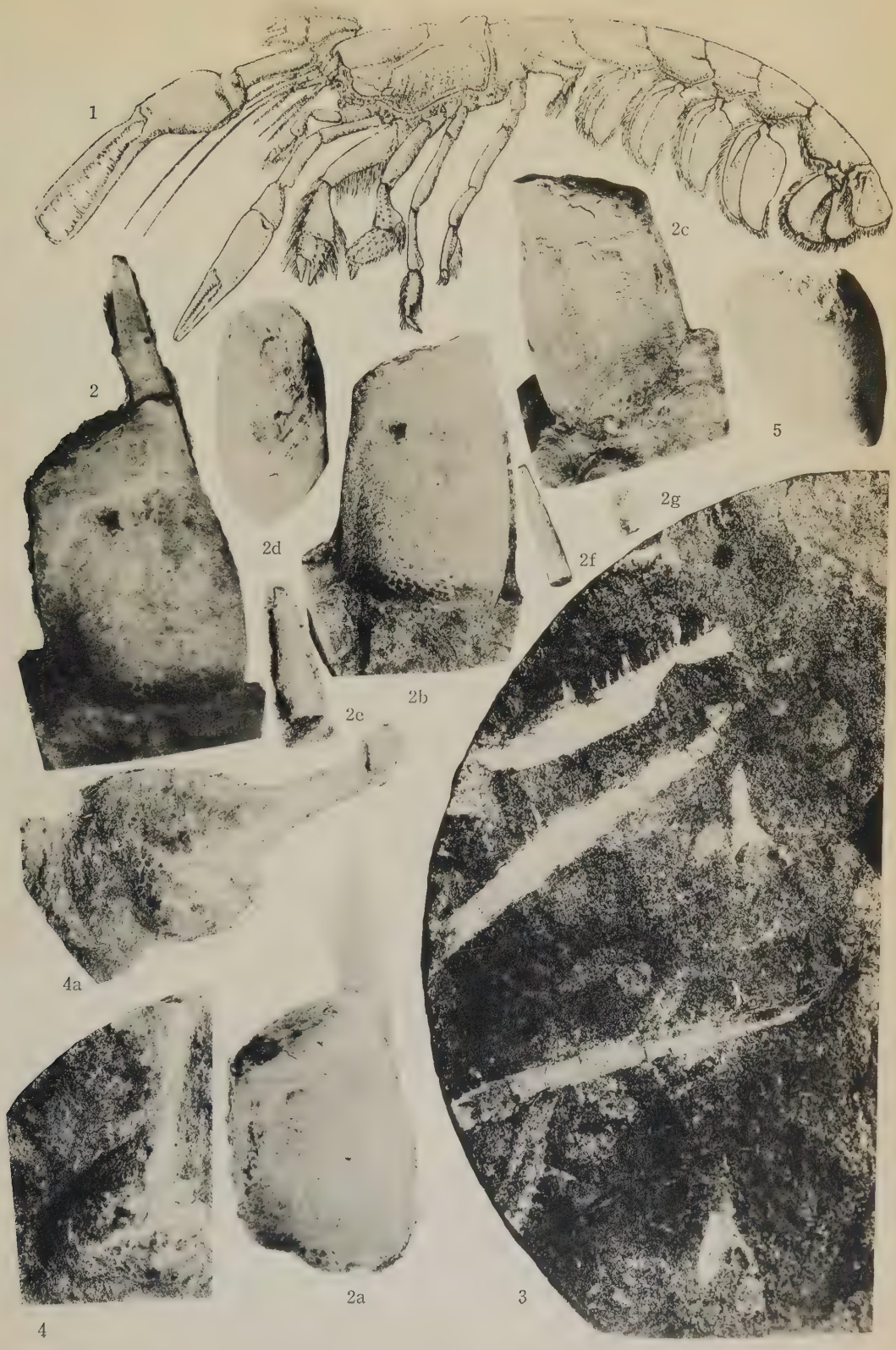
Fig. 2f. Fixed finger of the same specimen as fig. 2, lower view, × 2.

Fig. 2g. Fixed finger of the same specimen as fig. 2, anterior view, × 3.

Fig. 3. Syntypes No. II-V, four fingers of the larger chela (perhaps, left one) and the right immovable finger of the second pereiopod, syntype No. VI, × 2.

Fig. 4. Syntype No. VIII, anterior part of the left manus with the stump of the fixed finger, × 23/12.

Fig. 4a. Same specimen as fig. 4, × 13/6.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PROCEEDING OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

「日本古生物学会 第70回 例会」1958年6月6日 北海道大学 理学部 地質学 鉱物学教室において開催した。(参会者 13 名)。例会における講演者並びに講演題目は次の通りである。

1. *Parafusulina* and *Pseudodoliolina* found in the Base of the Kamiyoshida Group, the Uppermost Strata of the Chichibu System, Kanto Massif ..... Rokuro Morikawa
2. On some Fusulinids from the Higashizawa Valley, Maniyoshida-mura, Chichibu-gun, Northern Part of Kanto Massif..... Rokuro Morikawa
3. Fusulinids from Shiroishi-yama, Northern part of Kanto Massif ..... Rokuro Morikawa
4. Foraminifera from the Akahira Group in the Northeastern Corner of the Chichibu Basin, Central Japan..... Hiroshi Ujiié
5. 石川県七尾石灰質砂岩層の蘇虫類について ..... 高橋直二
6. *Plicatounio* of the Wakino Formation.. :..... Yoshihisa Ohta
7. Miocene *Perotrochus* and its Associated Fauna from Tochigi Prefecture, Japan ..... Saburo Kanno
8. On Some Morine Miocene Mollusca from Mie Prefecture, Japan ..... Yoshio Araki

「日本古生物学会第71回例会」1958年9月27日 京都大学 理学部 地質学 鉱物学教室において開催した (参会者 12 名)。例会における講演者並びに講演題目は次の通りである。

1. 有孔虫の生体に関する2, 3の観察と方法 (予報) ..... 森島正夫・千地万造
2. On Some Carboniferous Corals from the Kitakami Mountains (代読) ..... Makoto Kato
3. The Upper Palaeozoic Corals from the Southern Part of the Tanba District, Japan .....Shigeo Sakaguchi and Noboru Yamagiwa
4. Two Cephalopod-Species from the Norian Nariwa Group Western Japan.... .....Keiji Nakazawa
5. Pelecypods of the Mizunuma Jurassic in Miyagi Prefecture with some Stratigraphical Remarks (代読)..Itaru Hayami
6. Taxonomic Notes on Genus *Cardinia* with Description of a New Species from the Lower Lias of Western Japan (代読) ..... Itaru Hayami
7. Bajocian Pelecypod Fauna of the Aratozaki Formation in Northern Japan (代読)..... Itaru Hayami
8. On *Kumatrigonia*, a New Subgenus of *Frenguelliella*, and a *Tosapecten* from the Carnic Tanoura Formation, in Kyusyu, Japan (代読).....Minoru Tamura
9. Carnic Pelecypods of Matsukuma in Central Kyushu, Japan (代読) ..... Minoru Tamura
10. Trigoniidae, Ostreidae, Bakevelliidae, Pteriidae, Cardiidae and Astartidae from the Upper Jurassic Sakamoto Formation in Central Kyusyu, Japan (代読)..... Minoru Tamura
11. Taxodonta and Isodonta from the Upper Jurassic Sakamoto Formation in Central Kyushu, Japan (代読)..... Minoru Tamura
12. *Trigonioides* and its classification (代読) ..... Yoshihisa Ohta
13. On the "*Nippononaia*" from the Lower Cretaceous Wakino Subgroup, North Kyusyu, Japan (代読)....Yoshihisa Ohta
14. 仙台付近中新統産 Pectinidae (その 14), *Pecten swiftii* Bernardi について (代読) ..... 増田 孝一郎

SYSTEMATIC INDEX

(Note: Every reference is to the number of article)

PALAEOZOOLOGY

Protozoa

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PALAEOBOTANY

Miscellanea

INDEX OF FOSSILS

Notes: Every reference is to the number of article; words in italics are names of genera and species; words in heavy type, names of new families, genera and species.

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NEWS

International Oceanographic Congress は New York の United Nations Building で 1959 年 8 月 30 日から 9 月 12 日まで開かれる。ここでは (1) The History, (2) The Boundaries, (3) The Deep Sea, (4) Dynamics of Organic and Inorganic Substances 及び (5) The Marine Lift Regime の 5 symposia が計画されているが第 5 の symposium では次の 5 問題が討議される。

(a) The palaeogeography of marine floras and faunas,
(b) Biogeographical regions in the sea,
(c) Evolution and adaptation in the sea,
(d) The behavior of marine organisms as influenced by environmental factors,
(e) Physiology of marine plants,
(f) The culture of marine organisms as a means of understanding evironmental influence on populations.

詳報は下記に問合せればよい。Dr Mary Sears, Chairman, Woods Hole Oceanographic Institution, Woods Hole, Mass., U. S. A.

4th Panafrican Congress on Prehistory はベルギー領コンゴの Leopoldville で 1959 年 8 月 24 ～29 日に開催されることになった。会議は第 1 部地質学関係，第 2 部古生物学関係，第 3 部先史考古学関係の 3 部門に分かれて開かれる予定である。
詳細は下記に問合せられたい。

Secrétariat du IVme Congrès Panafricain de Préhistoire
Laboratoire de Géologie
Universite Libre de Bruxelles
50, avenue F.-D. Roosevelt
Bruxelles (Belgique)

日本古生物学会例会通知

	開催地	開催日	講演申込締切日
1958年総会,年会	東京大学	1958年12月6,7日	1958年11月15日
第72回例会	広島大学	1958年2月14日	1959年1月20日

1958年11月5日 印刷
1958年11月10日 発行
定価 1部 250圓
東京大学理学部地質学教室内
日本古生物學會
編集者 小林貞一
発行者 市川健雄
(振替口座東京84780番)
印刷者 東京都港区芝浦1丁目1
株式會社 ヘラルド社 富田元

購読申込は下記の賣捌店へ申込下さい
東京都千代田区神田神保町1丁目7
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